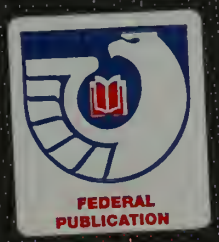


PARK SCIENCE
Integrating Research and Resource Management

Volume 16–Number 1 National Park Service • U.S. Department of the Interior Winter 1996

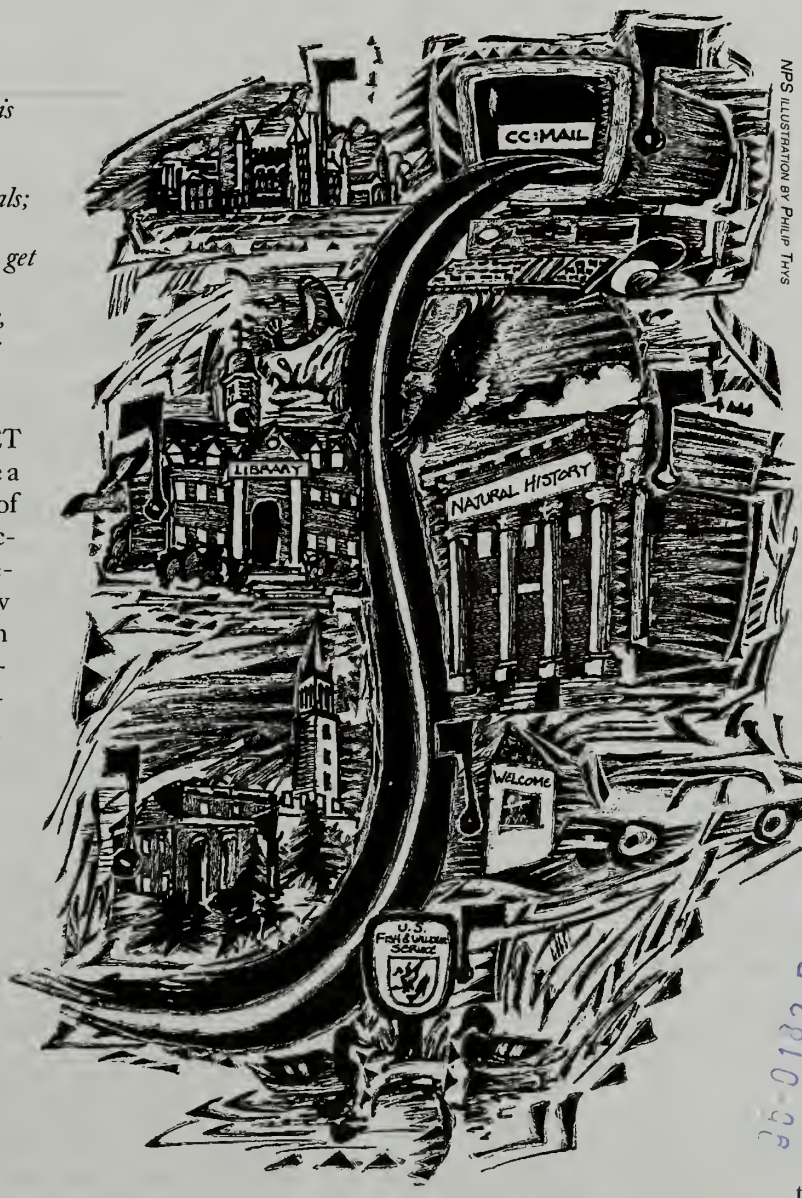
Retrieving Biological Information Over the Internet

A Primer for Resource Professionals Using cc:Mail

By Stephen Fettig

Editor's Note: This article is limited to examples for biologists, ecologists, and natural resource professionals; however, the same e-mail access routes can be used to get legal, law enforcement, geological, cultural resource, and other information over the Internet.

THE INTERNET has fast become a common part of our lives. Electronic mail (e-mail) addresses are now given out routinely in magazines and on television and radio shows allowing viewers and listeners to ask questions or send comments. Some program hosts and commercial enterprises even point computer users to multimedia World Wide Web pages–the newest and perhaps most popular way of exploring the Internet–for further information. Many state and federal government agencies also have Web pages (including the National Park Service), along with most universities and research centers around the world. Many of these Internet sites provide a great deal of interesting and useful biological information. While some NPS staff already have access to the World Wide Web and its multitude of biological resources, most park employees only have access to cc:Mail, the NPS e-mail software.



NPS ILLUSTRATION BY PHILIP THYS

The information superhighway is fast connecting land managers with universities, libraries, the Smithsonian Institution, and museums.

To many people it may come as a surprise that most Internet information is available to park personnel right now, with nothing more than our current cc:Mail system. Everyone with access to cc:Mail has access to the Internet. In reality, everyone with e-mail is already part of the Internet, although in a limited way (see side bar on page 16 explaining levels of connectivity). No new hardware, software, or computer equipment is needed to get information from computers from all over the world. Don't get your hopes up too high, however, if the only connection you have to the non-NPS world of com-

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PARK SCIENCE

Integrating Research and Resource Management

Volume 16—No. 1 • Winter 1996

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

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EDITOR
Jeff Selleck

Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. The bulletin is published in January, April, July, and October for distribution to interested parties.

The editor welcomes submissions of case studies, feature articles, highlights, and others. See *Park Science* 14(4):13 for submission criteria or contact the editor at:

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Printed on recycled paper

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FEATURES

IN THE NEXT ISSUE. . .

Look for the articles that were promised for this issue on landslide assessment at Hagerman Fossil Beds and a look back at the first class of natural resource management trainees in 1984. Also, economic assessment of parks in Virginia, rare aster surveys in Alaska, and the pitfalls of pseudoreplication, where ecology research findings can mistakenly be applied too broadly.

1995 At a Glance

To historians, the indexes on pages 29-31 of articles published in *Park Science* during 1995 are more than just tools to find information. They also constitute a barometer, indicating the events we considered to be significant enough to document. At a glance, they share advances and declines in the state of the art of research and its application in park resource management. They also reflect the dedication and morale of the professionals that make the connection between research and its use in park management on a daily basis. A snapshot in time, these indexes reveal trends that help us assess where we are and where we are going.

In reviewing the approximately 45 features published last year, several themes are evident. Many focused on projects that could not have been accomplished without the help of partners. As these articles detailed, we do not stand alone in our work, and must reach out to cooperators who can provide funds, staff, equipment, or expertise to help us achieve our goals. Population and landscape ecology articles also appeared, indicating that while we are just beginning to explore ecosystem management, the resources we care for clearly interact in a world that extends far beyond park boundaries.

Restoration activities triumphed in 1995. While the articles probably told only the most successful stories, they showed that with adequate planning, research, funding, and public support, we can bring threatened, endangered, or displaced resources back into areas where they once occurred. Once again we also seem to be making progress, in the post-Yellowstone fires era, in incorporating prescribed natural fire into the scheme of our resource management activities.

Where *Park Science* usually reports techniques, we also delved into analyzing the effects of government reinvention on our work. In this issue, the article on page 24 continues this trend and looks into many of the ramifications of restructuring on resource management.

What will prevail in 1996? Our cover story on retrieving biological information over the Internet may foretell of what is to come. The information age is bringing us greater opportunities to find information easily, even in remote settings, and these opportunities are sure to expand.

Park Science will even take the plunge into cyberspace this spring by appearing regularly on the World Wide Web. Printed copies will continue to be circulated and the publication will continue to be edited for core readership, but this electronic medium will help us reach a larger audience and generate stronger interest and support for research and resource management programs. Perhaps historians will remember 1996 as the year that we began to use computers more frequently than printed journals to learn about advances in our fields?

Jeff

News & Views

Dear Editor,

On page 13 in the Highlights section of the Fall 1995 issue you noted that "NPS officials are able to support delisting the peregrine falcon from endangered to threatened status." The U.S. Fish and Wildlife Service (FWS) published a notice that they are considering removing the species from protection under the Endangered Species Act entirely, *not* downlisting the species to "threatened status" (Federal Register. 1995 Jun 30. 60(126):34406-34409). The Fish and Wildlife Service has not yet proposed funding a scientifically credible peregrine falcon monitoring program; rather they will "describe" a monitoring plan in the proposed rule to delist the species. It is extremely doubtful, given recent cuts to the FWS endangered species budgets, that they will fund a scientifically credible monitoring program once the species is delisted.

Mike Britten
Wildlife Biologist
NPS Colorado Plateau SSO

Dear Editor,

I am a university scientist who has worked on a number of NPS research projects and have received *Park Science* for some time. For us "outsiders," an article on the NPS reorganization would be very helpful, particularly how it affects the NPS research efforts... What has transpired in the reorganization is very much a mystery to me.

Jim Gregory
Department of Forestry
North Carolina State University

Editor's Note: *The article beginning on page 24 addresses some consequences of the NPS reorganization on research.*

Parks designated world heritage sites

What do the Taj Mahal, the cliff dwellings of Mesa Verde, the Great Barrier Reef in Australia, and the Egyptian Pyramids have in common with Glacier, Waterton Lakes, and Carlsbad Caverns National Parks? They are all world heritage sites. The world heritage site designation recognizes both natural and cultural sites that have been deemed to be of outstanding universal value to all citizens of the world. The honor was bestowed on the parks at a December meeting of the World Heritage Committee in Berlin, Germany.

The World Heritage Convention, an international treaty ratified by 147 nations, governs the designation and preservation of world heritage sites. To be inscribed a world heritage site, nominees must meet several criteria that define "outstanding universal value." For example, natural site nominees must exhibit major stages of earth's natural history or its ongoing geological, ecological, or biological processes, among other criteria. Conditions of integrity must also be met that include size and legal protection. To carry out the field evaluations, the committee contracts the independent organizations IUCN (International Union for the Conservation of Nature) and ICOMOS (the International Committee on Monuments and Other Sites).

Nominated for world heritage site status in 1994, Carlsbad Caverns now joins Chaco Culture National Historical Park and Taos Pueblo as New Mexico world heritage sites. One of the deciding factors in the

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Continued

Carlsbad addition to the list was Lechuguilla Cave and the many scientific discoveries made there since 1986. Also contributing to the designation were other park geological and biological features, park size, beauty, and the significance of its most famous cave, Carlsbad Cavern.

Glacier National Park was first nominated for the distinction in 1984; however, consideration was deferred until 1993 when Glacier and Waterton Lakes were nominated jointly. The Waterton-Glacier International Peace Park was recognized for its biological diversity and natural beauty. The two parks sustain exceptionally diverse and productive habitats, reflected by the natural populations of large mammals and carnivores, including wolves, grizzly bears, and mountain lions. Glacier plans to use the designation to amplify its role in achieving and maintaining an international ecological complex.

The three newly designated parks join the list of 360 world heritage sites occurring in 83 countries that includes the Great Wall of China; Sagarmatha (Mt. Everest) National Park; Kilimanjaro National Park, Tanzania; the Galapagos Islands; the Statue of Liberty; Grand Canyon, Hawaii Volcanoes, Mammoth Cave, Mesa Verde, Everglades, and Yellowstone National Parks; Independence Hall; and the old city of Jerusalem among others. The United Nations Educational, Scientific, and Cultural Organization oversees both the World Heritage Site and Biosphere Reserve Programs.

Kimball honored

National Park Service Water Resources Division Chief Dan Kimball received the prestigious 1995 Stephen Tyng Mather Award for national park resource conservation at the annual Association of National Park Rangers Ranger Rendezvous in St. Paul, Minnesota, last November. Named for the first NPS director, the award is given annually by the National Parks and Conservation Association to a federal employee for exemplary efforts to protect national park resources. Kimball was recognized for his many significant protections that have been won for national park resources, especially water resources, in large part due to his fine ability to bring into agreement opposing views in controversial issues.

NPS Water Resources Chief Dan Kimball

Since he became branch chief for planning and evaluation in the NPS Water Resources Division in 1983, Kimball has consistently led the fight to preserve national park resources. He was instrumental in preventing the siting of a nuclear waste repository next to Canyonlands National Park, Utah, in 1985. Later, as the NPS representative working with an international joint commission, he orchestrated inquiries into the danger posed to Glacier National Park, Montana, by the proposed Cabin Creek coal mine. Permits for the mine were denied and the facility never opened. He also played a major role in successful efforts to minimize damage to Grand Canyon National Park caused by water releases from the Glen Canyon Dam. And when the threat of geothermal leasing outside Yellowstone National Park was imminent, Kimball helped forge a compact with Montana that put strict limitations on the allocation of surface and subsurface geothermal waters. Most recently, during restructuring, Kimball has been helping to lead the drive to preserve the NPS scientific ability to protect parks. "Good science, along with adequate inventory and monitoring capabilities, is crucial to preserving park resources," Kimball commented.

Recipients of the Mather Award have demonstrated initiative and resourcefulness in promoting environmental protection; they have taken direct action where others have hesitated, and they have placed commitment to principle ahead of job security in the pursuit of good stewardship of the national parks. The honor included a $2,500 cash grant donated by Faultless Starch/Bon Ami Company of Kansas City, Missouri.

Jury convicts wolf's killer

A federal jury of 12 Montanans deliberated less than 2 hours on October 25 in Billings to convict Chad McKittrick of Red Lodge, Montana, of three counts of killing, possessing, and transporting a wolf. The 122-pound male wolf had been acclimated and released from the Rose Creek pen inside Yellowstone National Park as part of the northern Rocky Mountains wolf recovery effort, begun over a year ago in both the park and central Idaho. McKittrick was accused of shooting the wolf last April 24 while black bear hunting with a friend near Red Lodge.

The silvery-gray male wolf, known as R-10, had sired a litter of 8 pups who were born near Red Lodge about the time of the shooting. Biologists learned of its death when its radio collar transmitted a mortality signal. They found the collar near a public road; following an area search, they were led to McKittrick's home by his hunting partner, where they found the head and pelt.

McKittrick could be sentenced to up to 6 months in prison and fined $25,000 for possessing and killing the wolf, which are violations of the Endangered Species Act. Maximum penalty for the transportation count, a high misdemeanor, is a year in prison and a $100,000 fine. McKittrick has yet to be sentenced.

After the shooting, biologists moved R-10's mate and her pups back to a Yellowstone pen, concerned that the nursing mother might starve without the father's help. Shortly before the trial, biologists released the mother and her growing pups back into the park. In mid-De-

cember, a delivery truck accidentally hit and killed one of the pups (then 70 pounds), but the others remain healthy. Another male from a different pack has recently joined the adult female's group, now roaming as a pack in the Lamar Valley in Yellowstone.

Wolf restoration activities in Yellowstone and central Idaho are continuing this winter. Private funds are being used to augment the federal monies used to capture and transport wolves from Canada to the restoration sites. Biologists have already released 8 wolves, with 6 or 7 more to come, in central Idaho and transported 11 wolves to Yellowstone acclimation pens where they will remain for 10 weeks before being released. The park anticipates receiving 6 or 7 more wolves this winter.

NBS names science center directors

In a spate of activity last fall, the National Biological Service (NBS) announced the selection of four biologists to serve as science center directors around the country. Dr. James A. Kushlan, an internationally renowned wetlands scientist, has been named director of the Patuxent Environmental Science Center. Located in Laurel, Maryland, this center focuses its research on environmental contaminants, populations and habitats of migratory birds, endangered species, urban ecology, and vertebrate systematics in the eastern United States. Field stations reporting to this director include the Northeast Research Station in Orono, Maine and the Center for Urban Ecology in Washington, D.C.

Biologist and geneticist Dr. William Mokahi Steiner will head the Pacific Islands Science Center located in Honolulu, Hawaii. His responsibilities will include directing research into the uniqueness, diversity, stability, and conservation of Hawaiian ecosystems and various Pacific Islands under U.S. jurisdiction. Projects currently under way there address ecosystem degradation resulting from biodiversity loss, endangered species surveys and recovery, and nonnative species monitoring and management. An estimated 35% of the endemic plant species and 76% of the endemic bird species in Hawaii are extinct, endangered, or need protection.

The Northwest Biological Science Center in Seattle, Washington, also has a new director. Dr. Frank A. Shipley is experienced in dealing with estuarine issues and hopes to direct the science program to provide sound information on natural resource issues, including the complex and controversial plight of Pacific Northwest salmon. Established in 1934, the center is known internationally for fish disease research contributing to the success of salmon and steelhead hatcheries. Today, the center also emphasizes research in the Columbia basin and other Northwest river systems, and on forestry and wildlife concerns throughout the west.

Coming from a 9-year appointment as Director of the Alaska Science Center, Dr. A. William Palmisano, Jr., will head the Leetown Science Center in Kearneysville, West Virginia. A wildlife biologist and botanist, Palmisano will oversee a research program that concentrates on restoring and protecting aquatic species and their supporting ecosystems. Center scientists use specialized training in ecology, health and disease, genetics, behavior, population modeling, fish physiology, and aquatic populations restoration technologies to support management of healthy populations of declining or threatened fish and other aquatic organisms.

Biological data to go on-line

The National Biological Service and numerous partners have been busy arranging for several biological databases to go on-line. The products are either available now or will soon become accessible through the World Wide Web feature of the Internet.

The NBS and the Fish and Wildlife Information Exchange, in cooperation with the Organization of Fish and Wildlife Information Managers, are developing a directory of state biodiversity databases and information sources. The partners will compile information about biological databases and information maintained by state fish, wildlife, natural resources, and environmental agencies. The resulting directory will describe the contents and subject matter of each database or information product, give institutional and contact information about the source agency, and report the status of electronic accessibility of the information. The on-line directory will include direct "hot links" to agencies or organizations that already have data and information products available through the Internet. The directory will be accessible through the National Biological Information Infrastructure (NBII), a NBS initiative to foster the development of a distributed electronic network of biological data maintained by a variety of federal and state agencies, universities, museums, libraries, and private organizations. The Internet address for NBII is

"http://www.nbs.gov/nbii/".

Five federal agencies and the Smithsonian Institution have also joined forces with the National Biological Service to develop and support a new national database on the plants and animals of North America. The database, known as the Interagency Taxonomic Information System (ITIS), will provide for the first time a standardized source of information on the scientific names and synonyms, common names, and information about origin and general distribution of all biological species occurring in North America and adjacent waters. The database is accessible through NBII or directly through the ITIS home page at

"http://www.itis.usda.gov".

The National Biological Service is also the first bureau from the Department of the Interior to join CENDI, a federal information organization that works to improve the sharing, exchange, and dissemination of scientific and technical information. Member agencies jointly develop technical information directories, locator systems, standards for cataloging and indexing, while sharing costs and experience on new technologies for data and information exchange and networks. The group also provides user training and support through workshops and conferences. Its home page can be found at

"http://www.dtic.dla.mil/cendi/".

ALLEGHENY-CHESAPEAKE

Highlands Council formed

Nine federal agencies formed the Mid-Atlantic Highlands Coordinating Council in May 1995 to foster and promote efficiency in carrying out natural resource related responsibilities and activities in the Mid-Atlantic Highlands. The highlands comprise many distinct terrestrial and aquatic ecosystems, extending east and west from the Blue Ridge Mountains to Ohio, and north to south from New York to North Carolina-Tennessee. Within these boundaries, the highlands include the Blue Ridge Mountains, the Appalachian Mountains, and the Appalachian Plateau uplands.

In signing "The Highlands Accord," the council agreed to meet periodically and work together to achieve the following objectives:

- Promote better understanding of research, monitoring, and management activities currently underway in the Mid-Atlantic Highlands,
- Identify common goals and objectives,
- Explore ways to improve interagency cooperation, and, where consensus exists,
- Develop mechanisms for extended cooperation among federal agencies to support natural resource management, protection, and monitoring.

The coordinating council held a conference October 24-26, 1995, at Canaan Valley, West Virginia, to focus on the issues and concerns related to the valuable natural resources in the highlands. The group explored the history of the highlands and its current ecological and economic conditions. Participants heard perspectives from various organizations interested in the highlands and its values and opportunities. Finally, they presented case studies and discussed local organizations that are working together to achieve ecological and economic balance, thus promoting sustainability.

The nine signatory federal agencies are the U.S. Department of the Interior–National Park Service, National Biological Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, and Office of Surface Mining; U.S. Department of Agriculture--Forest Service, Natural Resources Conservation Service, and Agricultural Research Service; and U.S. Environmental Protection Agency. John Karish, Chesapeake and Allegheny System Support Office Senior Scientist, is the NPS council representative.

GREAT PLAINS

Ferret future looks bright

Multiple agency biologists working in Badlands National Park, South Dakota, ended 1995 with several encouraging findings regarding the ongoing black-footed ferret restoration. Between November 19 and December 15, they detected 16 live ferrets during spotlight surveys in and adjacent to the wilderness areas of the park. These animals included: 6 female and 3 male juveniles released last fall that have survived in the wild for more than 50 days; 1 male and 1 female (each 2 years old) released as juveniles in the fall of 1994 that have survived over 440 days in the wild, of which the female raised a wildborn litter last summer; and 3 1995-wildborn kits (gender undetermined). The ratio of 7 females to 4 males is expected to be adequate for reproduction. Additionally, the ferrets have become very effective predators with those surviving from the fall 1994 release having killed an estimated 125-150 prairie dogs each.

These findings support continued releases and follow-up research. An estimated 60% of 1995 kits born in the park have survived at least 3 months following dispersal from their mother's burrow. This is contrasted with a 30% survival rate of preconditioned juveniles released during 1995. Still, the 30% survival figure is among the highest monitored from the 8 fall reintroductions conducted to date in Wyoming, Montana, and South Dakota from 1991 through 1995.

The park anticipates a February 1996 release of 9 preconditioned juveniles. These 7 male and 2 female ferrets will have spent 2 ½ months in preconditioning pens. They will also be the first released in winter, just before breeding season.

PACIFIC-GREAT BASIN

BAER Team reduces fire impacts

From its beginning on October 3 on Mount Vision near Point Reyes National Seashore until containment 4 days later, the Vision Fire burned more than 12,000 acres of private, state, and federal lands. Winds of up to 45 m.p.h. quickly transformed a small fire ignited by the smoldering remains of an illegal campfire into a firestorm that took 45 homes in 24 hours. The nature of the landscape and proximity to private lands lead area managers to fight the fire aggressively.

A battle such as this cannot be won without some impacts to the landscape. Bulldozers plowed over 25 miles through thick vegetation in an effort to contain the blaze. Among the many unsung heroes are those that helped the land recover from the fire suppression efforts. At the request of Superintendent Don Neubacher, the Department of the Interior Burned Area Emergency Rehabilitation (BAER) Team arrived. The BAER team is made up of resource specialists with expertise in plants, animals, soils, water resources, cultural resources, structures, roads, and trails. Working for various federal agencies, the team members assessed the impacts made by the fire and suppression efforts and made recommendations to the superintendent and affected communities for both long- and short-term restoration.

The BAER team concentrated on rare plant populations that might be impacted by the burn and the invasion of nonnative species to the newly disturbed areas. They recommended monitoring to assess impacts to the rare plant populations and monitoring in conjunction with plant removal for nonnatives that are likely to grow along the dozer lines. The team also proposed that bulldozer lines be stabilized using materials such as wood mulch to prevent accelerated erosion on the steep topography of the park and its environs. Recommendations also included restoring helispots and safety zones to their prefire conditions, rebuilding fences, repairing bridges and other structures, and stabilizing an archeological site.

GULF COAST

Turtle nest success surveyed at Dry Tortugas

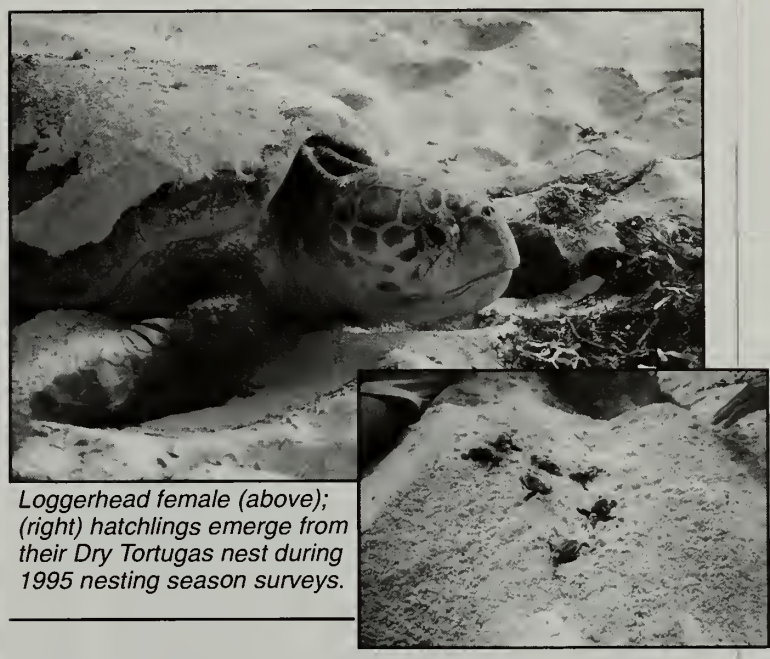
Located 70 miles west of Key West, Florida, the islands of Dry Tortugas National Park are the most pristine subtropical marine environment in the contiguous United States. The park supports the largest loggerhead turtle *(Caretta caretta)* rookery in the Florida Keys and perhaps the largest green sea turtle *(Eretmocheles imbricata)* rookery in Monroe County. However, before being established as Fort Jefferson National Monument in 1935 and Dry Tortugas National Park in 1992, the turtles were hunted to near extirpation by both mariners and local turtle canners. Today, the national park is a refuge for these nesting season residents, giving them a chance to recover from historic exploitation. Where habitat preservation has undoubtedly aided turtle recovery over the last 60 years, inventory surveys are providing nesting success information on which to base management decisions and future population trend comparisons.

The park began inventorying both the endangered green and threatened loggerhead turtles as early as 1980 in an effort to determine their populations and reproductivity. Unfortunately, these efforts were inconsistent and inconclusive. Then, investigators began a 3-year tagging operation, limited to one island where over half the park turtle nesting occurs, and tagged 44 loggerheads and 2 green turtles. After nearly a decade of no further inventorying activities, the park revived the surveys in 1994, concentrating on excavating nest sites (after the hatchlings emerged). From August through September, researchers counted 47 loggerhead and 25 green turtle nests. Although this research was incomplete, these results were exciting as this was the first time green sea turtles were verified as nesting in the park since the study of the early 1980s, and the 25 nests set a Monroe County record.

In 1995, recognizing a need for more comprehensive turtle research, the park recruited a Student Conservation Association-Americorps intern to expand inventorying to all park keys and make nesting observations throughout the entire nesting season. Investigator Scott Boykin explained that the April to September investigation period and consistent inventory methods distinguished the 1995 season from earlier efforts. "This project began before nesting and continued until all nesting was over," he said. "It provides the most realistic snapshot of turtle nesting activity on the Dry Tortugas to date."

During the study, Boykin determined that loggerhead turtles used 5 of the 7 islands within the park. Nesting success was generally high, with 79% of the loggerhead turtle eggs that were laid in successful nests emerging as viable hatchlings. Average clutch size was 98 eggs, with a range of 50-188. Average incubation was 54 days with a range of 45-58 days. Based on the estimate that loggerhead turtles nest an average of 4.1 times per season, 53 females used the Dry Tortugas in 1995.

Boykin also documented green turtle nesting in 1995, and found that numbers were down from 1994. In contrast to the more common loggerhead turtles, green sea turtles nested from late June to early August, used only one key, and produced 4 nests, of which only 3 were successful. Combined with the 24 successful nests of 1994 (27 total over 2 years), 78% of the successful green turtle nests produced viable hatchlings. The average clutch size from the 2 seasons was 124 with a range of 55-191. Average incubation for the 1995 nests was 51 days. Investigators estimate that 7 female green turtles used park beaches for nesting during both 1994 and 1995.



Loggerhead female (above); (right) hatchlings emerge from their Dry Tortugas nest during 1995 nesting season surveys.

The research also closely examined nesting loggerhead scute patterns to determine if hawksbill turtles were nesting in the park. The discovery of one nest with partially developed hatchlings possessing scutes characteristic of hawksbills indicated a possible nest of hybrids. After further analysis, however, the aberration was attributed to variation in loggerhead scutes.

Having had a successful 1995 field season, the park hopes to continue the surveys through 1998 because the typical nesting interval of loggerhead and green turtles is 2-3 years. This would allow for a proper assessment of turtle use patterns, seasonal fluctuations, and the population density of nesting females that use park beaches. Considering the historical importance of this rookery, a 4-year study would constitute the first comprehensive modern inventory, and would aid management in protecting the turtles. Boykin added, "the study is also important regionally as the Dry Tortugas are the least disturbed of any of the other Florida turtle nesting grounds. Results from these surveys will become valuable standards for regional comparison and for future park turtle population trend comparisons."

PS

1995 BIOSPHERE RESERVE MANAGERS WORKSHOP

BY ANTOINETTE J. CONDO

THE BIOSPHERE RESERVE Directorate of the United States Man and the Biosphere Program (USMAB) sponsored a biosphere reserve managers workshop held October 29-31 in Washington, D.C. Managers from across the country and representatives from Canada, Mexico, Germany, and Russia participated.

Karen Wade, Harold Smith, and Raymond Dasmann were all honored at the October 30 banquet. Superintendent Wade and staff of Great Smoky Mountains National Park, one of five units within the Southern Appalachian Biosphere Reserve Cooperative, and Superintendent Smith and staff of Organ Pipe Cactus National Monument and Biosphere Reserve were each presented a plaque by Dean Bibles, Chair of the USMAB National Committee, recognizing each site as "1995 outstanding U.S. Biosphere Reserve, a site of U.S. MAB excellence, demonstrating conservation and sustainable development on a regional scale." Bibles also commended Dr. Dasmann for his many years of service to the biosphere reserve program and the Golden Gate Biosphere Reserve in particular.

Guest speakers were John Reynolds, Deputy Director of the National Park Service; Gene Hester, Deputy Director of the National Biological Service; and the Honorable John Fraser, Canadian Ambassador for the Environment. Ambassador Fraser, Chair of Canada MAB; Miguel Equihua (for Gonzalo Halffter), Chair of Mexico MAB; and Dean Bibles, USMAB Chair, signed a memorandum of cooperation among biosphere reserves of the three countries.

Bibles also announced the creation of a new category of biosphere reserve to be recognized by the USMAB National Committee. The new category is designed to encourage participation in the principles of the biosphere reserve program among those who may not be prepared to join an international program. This designation would not preclude the biosphere reserve from seeking UNESCO recognition at a later time.

Several presentations and working groups addressed electronic communication involving biosphere reserves. John Dennis of the National Park Service, as facilitator with the technical expertise of Brand Niemann and Jennifer Gaines, both of the National Biological Service, explored the UNESCO-MAB Internet home pages. Professor James Quinn of the University of California, Davis, reviewed the MABFauna database, the accessibility of biological inventory data on the Internet, the development of the USMAB e-mail discussion group (see following article), and new USMAB project to provide software and technical support to additional U.S. biosphere reserves.

The chairs of the five USMAB research directorates reported on their multiyear research projects and discussed with managers ways to relate research to management needs. Case studies focused on the efforts of agencies, organizations, and local people to plan and implement the goals of the U.S. Biosphere Reserve Program. The case studies included:

- Southern Appalachian Man and the Biosphere Program (SAMAB) by Hubert Hinote of SAMAB;
- Sonoran Desert Biosphere Cooperative by Tony Ramon of the Tohono O'odham Nation and Harold Smith of Organ Pipe Cactus National Monument;
- Mammoth Cave Area Biosphere Reserve by Jeff Bradybaugh of Mammoth, Cave National Park;
- Colorado Rockies Regional Cooperative by Craig Axtell of Rocky Mountain National Park;
- Proposed Catskills Biosphere Reserve by Janet Crawshaw of the Catskill Center; Proposed Tijuana Watershed (U.S.-Mexico) by Fred Cagle of Immedsys, Ltd.;
- New Jersey Pinelands by Robert Zampella of the Pinelands Commission;
- Crown of the Continent Biosphere Reserve (U.S.-Canada) by Brace Hayden of Glacier National Park; and
- Proposed Ozark Highlands Biosphere Reserve by David Foster of the Ozark National Scenic Riverways.

Bill Gregg of the National Biological Service reported on the results of a survey of manager perceptions regarding the biosphere reserve program. Managers indicated many benefits from biosphere reserve status, particularly in facilitating ecosystem management (the most significant of the 16 benefits surveyed), promoting public environmental awareness, facilitating research and international cooperation, and addressing regional environmental problems. They cited increased local funding and staffing, more emphasis on long-term ecological research, and expanding local constituencies as the greatest needs for enhancing biosphere reserve activities.

Six working groups recommended ways to implement the goals of the Strategic Plan for the U.S. Biosphere Reserve Program. These goals focus on communication, education and training, local participation, operational framework, research and monitoring, and filling biogeographic gaps in the network. The summaries of recommendations for the working groups will be available in hard copy from the USMAB Secretariat, and on the USMAB home page:

"http://www.nbs.gov.nbii/mab/".

PS

Antoinette Condo is the Program Officer for USMAB. Her phone number is (202) 776-8316; fax (202) 776-8367.

USMAB e-mail discussion group gets underway

The purpose of this e-mail forum is to facilitate communication among agencies, organizations, and individuals participating in USMAB and the world network of biosphere reserves. Topics of particular relevance to this group include, (1) discussion of issues relating to the Man and the Biosphere Program; MAB interdisciplinary research proposals and ongoing projects; U.S. participation in MAB international networks; (2) biosphere reserves, including building an electronic network connecting U.S. biosphere reserves; linking MAB with other programs concerned with ecosystem

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CROP OF ISLAND PRESS RELEASES WORTH PERUSING

By Jean Matthews

ISLAND PRESS, THE ONLY nonprofit organization in the United States whose principal purpose is publication of books on environmental issues and natural resource management, has been busy publishing several works over the last 18 months. Highlights include:

The *Grizzly Bears of Yellowstone: Their Ecology in the Yellowstone Ecosystem, 1959-1992,* by John J. Craighead, Jay S. Sumner, and John A. Mitchell, all of the Craighead Wildlife-Wildlands Institute. Published last September, it has 88 figures (6 in color), 202 tables, 146 black and white photographs, 69 color photos, 448 references, and over 1,800 index entries. The hardcover book sells for $100. ISBN: 1-55963-456-1.

Three others are paperbacks:

Compass and Gyroscope, by Kai N. Lee argues that sustainable development is not a goal, not a condition likely to be attained, but rather (more like freedom or justice) a direction in which we strive. He starts by imagining that the concept is like Utopia–a faraway, perhaps imaginary island–and that humanity searches for it in a ship guided only by a "compass" of science and a "gyroscope" of politics. The subtitle is "Integrating Science and Politics for the Environment," and the book purports to be a "practical yet innovative guide to environmental management." It is 6"x9" in size, 243 pages long, with figures, maps, and index, and costs $16.95. ISBN: 1-55963-198-8.

Wildlife Policies in the National Parks was published in July 1995 and is the result of a 5-year study of NPS wildlife management policies. All of its seven authors are distinguished professors, who have had much experience working in the area of NPS wildlife management and its consequences. Hal Salwasser and Joseph Sax are best known to me, and they are impressive; I suspect the rest measure up. Sax wrote *Mountains Without Handrails,* which is now a classic work on the national parks, and is currently a counselor to the Secretary of the Interior. In the "Future Directions" section, the parts about the research role in the national park system and the functions of science in the system are worth the price of the book. The latter talks about building bridges between the National Park Service and National Biological Service, and shares problems and approaches to solutions. It also mentions "weak leadership at the top" in the past, and concomitant failure "to convey a strong sense of mission, commitment, and pride." It is 6"x9", 300 pages, has figures and index. Cloth: $49.00; ISBN: 1-55963-404-9; Paper: $26.00; ISBN: 1-55963-405-7.

Environmental Policy and Biodiversity, edited by R. Edward Grumbine, examines the need for scientists and policy makers to work together if solutions to the biodiversity crisis are to be found. This book presents an overview of important concepts in the field of conservation biology and an examination of the strengths and limitations of the policy making process. The essays come from a broad range of disciplines, are provocative and clearly argued. They discuss the ethical and scientific bases for conservation biology, the effectiveness of existing policy, numerous case studies from around the nation, and overall environmental policy goals and processes. The essayists are nearly a score of experts in this field, beginning with Michael Soule and continuing with that caliber of persons. (The editor is director of the University of California, Santa Cruz, Sierra Institute, and he lives in Rattlesnake Gulch, Bonny Doon, California... an address that fascinated me). It's 6"x9", 416 pages, contains figures, tables, and an index. Hardcover: $45.00; ISBN: 1-55963-282-8. Paperback: $22.00; ISBN: 1-55963-283-6. It was published in October 1994.

Island Press is located at 1718 Connecticut Avenue, N.W., Suite 300; Washington, D.C. 20009; (202) 232-7933; fax (202) 234-1328.

Jean Matthews is the founder and former editor of Park Science. She is enjoying retirement in Vancouver, Washington.

KEYSTONE CENTER MEETING ON ECOSYSTEM MANAGEMENT

BY KAREN WADE

FOR THE PAST YEAR, DR. John Dennis of the NPS Natural Systems Management Office and I have participated in a series of meetings sponsored by the Keystone Center (see sidebar) entitled "The National Dialogue on Ecosystem Management." Fifty people from diverse places and viewpoints are exploring the possibility of achieving consensus on whether ecosystem management offers a realistic new process within which to design and implement policies and decisions affecting natural resources. Represented are academics, agency bureaucrats and scientists, ranchers and forest products executives, and advocates from institutions as diverse as The Nature Conservancy, the Wilderness Society, and the Farm Bureau. Three of four plenary sessions have been completed and supplemented by break-out meetings organized as field trips to look at examples of ecosystem management. The latest meeting, held in Chicago early last November, was largely devoted to constructing the basic outline of a final product to be completed at the final plenary this March.

This dialogue was largely generated by the recognition that contemporary institutions and concepts are not capable of resolving the cross-boundary issues raised by our new understanding of natural systems and the increasing conflicts over scarce natural resources. In earlier meetings we defined "boundaries" not only as the obvious physical, natural, and political boundaries, but also those created by narrow academic disciplines, rigid property rights and tax codes, outdated economics, legal doctrines, antiquated managerial and institutional structures.

In all of our meetings, we have been privileged to be able to confer with those in our group who can articulate the growing sense of disenfranchisement expressed in grassroots rebellions. Grassroots rebellions are not only producing an agenda for the political process, but also generating interest in landscape level solutions created in a nonconfrontational, voluntary consortium of affected parties. The investigation of this phenomenon is what has brought us together and, we hope, will result in a clear articulation of the benefits of the approach and what might be done to actually strengthen it.

In order to define these landscape level management efforts, we have observed various examples believing that the definition lies in the practice. Those that exemplify ecosystem characteristics reflect sociological, economic, and ecological objectives in an integrated process that manages across jurisdictional boundaries. Most importantly, those that appear to be the most successful require stakeholder involvement that is fully collaborative and voluntary. Again, those collaborating are looking at units of management that reflect ecosystem patterns, like major watersheds, and consider all natural and cultural elements in an interdisciplinary context. In many of the best examples, government representatives are playing more of a participative or support role to a locally driven initiative.

Our inquiry has focused largely on the process of decision making. The process is built on trust, mutual respect, and a genuine partnership of stakeholders. The structure is centered around strategic planning and negotiation with values explicitly stated, goals defined in outcomes, and landscape level involvement in decisions that directly affect those at the table.

Observing this grassroots phenomenon in practice has led me to believe that there is something of value occurring spontaneously across the country that may well lead to a dramatic change in the institutions in which we all work. The examples we have observed are extremely diverse in adapting to the environments and cultures of the landscapes within which they are located, but they have generic characteristics, such as being adaptive, flexible, collaborative, interdisciplinary, or involving partnerships. They appear to provide an excellent model for interorganizational efforts that cross old agency boundaries and involve communities in a partnership. I like what I am seeing and look forward to being able to provide my colleagues with a copy of the final product.

PS

The Keystone Center, located in Keystone, Colorado, is a private, nonprofit organization. Under the auspices of its Science and Public Policy Program founded in 1976, the center facilitates the resolution of national public policy conflicts through the use of a consensus dialogue approach.

Keystone's mission is to design and facilitate innovative processes to address complex and controversial issues and assist participants in the development of productive and practical solutions. At stake in most of the issues Keystone facilitates is quality of life, the economy, and utilization and conservation of natural resources.

Karen Wade is Superintendent of Great Smoky Mountains National Park, Tennessee and North Carolina. Her phone number is (615) 436-1200.

PARTNERS IN FLIGHT CONSERVATION PLAN:

Building Consensus for Action at the 1995 International Workshop

OCTOBER 1-5, 1995, CAPE MAY, NEW JERSEY

BY MIKE BRITTEN, KATY DUFFY, MARK SCHROEDER, AND GARY JOHNSTON

MORE THAN 550 PARTICIpants from state and federal agencies, conservation groups, private organizations, and Latin America attended the 1995 Partners in Flight International Workshop last October 1-5 in Cape May, New Jersey. The workshop goal was to begin developing an international migratory bird conservation plan.

A basic tenet of the Partners in Flight (PIF) conservation effort, begun in 1990 to conserve neotropical migratory birds, is that hundreds of migratory bird species are at risk. Neotropical migrants are those birds that winter in Central or South America and nest in North America, making coordination of both breeding and wintering habitat conservation especially important. The ecosystems on which these species depend extend across political and management boundaries throughout the western hemisphere. Impacts to breeding or wintering areas or to migratory stopover areas threaten the long-term survival of many of these species. Ecosystem management, on a grand scale, is necessary to conserve migratory species.

Our efforts are carried out by state and regional working groups and overarching monitoring, research, international, and information and education working groups. An international Partners in Flight conservation plan is necessary to coordinate and strengthen these efforts. The plan has a precedent in the North American Waterfowl Conservation Plan.

Dr. Michael Soule, science advisor to the Secretary of the Interior, gave an inspiring opening to the conference by reminding us that species protection, i.e., protection of biodiversity, is the basic need. Dr. Jack Ward Thomas, Director of the U.S. Forest Service, vowed his commitment to protecting natural systems on public lands. Noting that public lands are essential to preserving biodiversity, he warned us to beware of congressional intent to "devolve" the Bureau of Land Management and other public lands by turning over management to the states whose, primary goals may not include species conservation. Dr. Thomas pointed out that Forest Service lands contain the most breeding bird habitat under one jurisdiction in the United States and that congress recently cut funding for his agency's migratory bird monitoring programs.

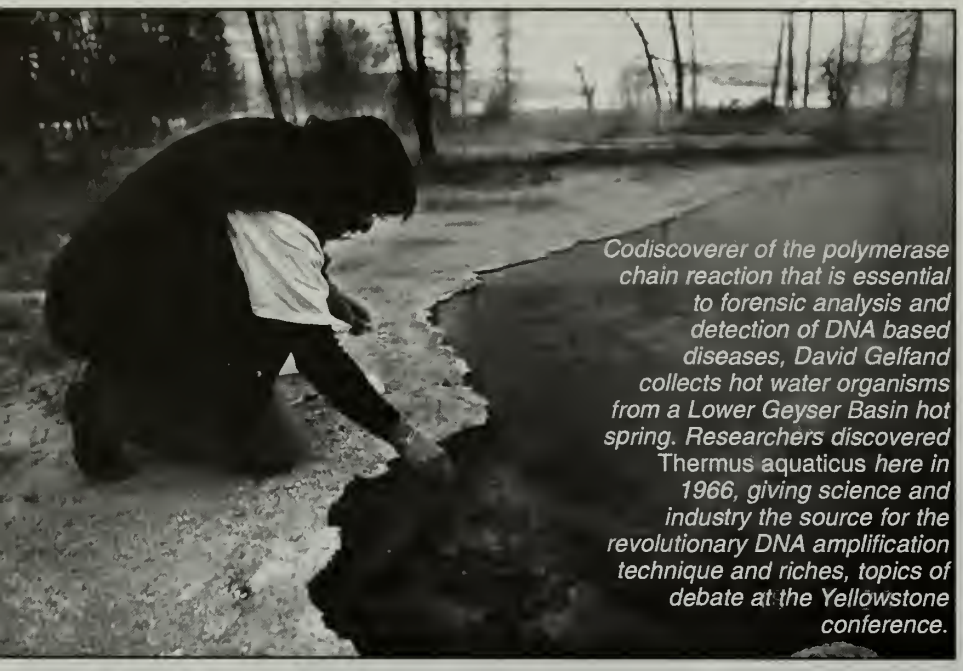
Mr. Steve Wendt of the Canadian Wildlife Service, recommended using birds as a link for conservation across international boundaries by designing bird monitoring programs (e.g., the joint America-Canadian bird banding effort) with a hemispheric approach. Dr. Roberto Roca, of the Nature Conservancy, outlined the challenges to the Partners in Flight initiative in Latin America. He noted that Latin America contains 50% of all avian species known on earth (3,000+ species) and 175 different ecosystems. While conservation of North American species that winter in Latin America is important, conservation of incredible biodiversity of the neotropics is critical. A major challenge, he explained, is international coordination and cooperation given that 40 countries and more than 200 indigenous languages exist in Latin America.

On Monday morning, a panel discussed "A Study in Bird Conservation Planning: the Mississippi Alluvial Valley." Only 4 million of the original 24 million acres (1.6 and 9.7 million hectares, respectively) in this area remain in their natural state. Habitat conservation needs in the area are integrated through cooperative planning (among corporate landowners, government agencies, academic institutions, and conservation organizations) for all birds including waterfowl, shorebirds, and migratory land birds. This presentation made obvious the preference of protecting systems before they are drastically altered because recovering highly modified systems is very expensive. Regional conservation plans like the Mississippi Alluvial Valley plan are a model for the Partners in Flight International Conservation Plan.

Terry Rich of the Bureau of Land Management presented results from his nationwide survey of PIF activities by state. Thirty-seven states have formed state working groups to coordinate and implement PIF actions. Eight states have either full-time or part-time paid coordinators. The National Park Service was recognized as making significant contributions to 12 state working groups. The broad conclusion from the survey is that although every state program is different, states are accomplishing migratory bird conservation through Partners in Flight. The greatest advances occur where infrastructure (e.g., a state working group or steering committee or a dedicated PIF coordinator) exists to implement the goals and objectives of the organization. Partners in Flight is currently recruiting and hiring coordinators for four of the regional working groups (Northeast, Southeast, Midwest, and West).

At the workshop, the International Association of Fish and Wildlife Agencies (which includes all 50 state wildlife agencies) introduced us to "Teaming with

Continued in column 2 on page 19



Codiscoverer of the polymerase chain reaction that is essential to forensic analysis and detection of DNA based diseases, David Gelfand collects hot water organisms from a Lower Geyser Basin hot spring. Researchers discovered Thermus aquaticus *here in 1966, giving science and industry the source for the revolutionary DNA amplification technique and riches, topics of debate at the Yellowstone conference.*

BIODIVERSITY, ECOLOGY, AND EVOLUTION OF HOT WATER ORGANISMS IN YELLOWSTONE NATIONAL PARK:

Symposium and Issues Overview

BY BOB LINDSTROM

THE GREATEST CONCENtration of experts in the field of Yellowstone microbiology held a highly successful 4-day symposium at Old Faithful, September 17-20, 1995. Organized by the Yellowstone Center for Resources and aquanaut-microbiologist Anna-Louise Reysenbach of Rutgers University, the symposium aimed at increasing communication and establishing contacts among the academic, biotechnology, and resource management communities. Three government agencies (NASA, National Science Foundation, and the Department of Energy) and 17 biotech companies, all interested in advancing knowledge and generating research into the fascinating world of life at high temperatures, funded the symposium. The synergy, communication, and contacts fostered amongst scientists, biotech companies, and resource managers in this esoteric research field went a long way toward elevating the profile of this important Yellowstone natural resource.

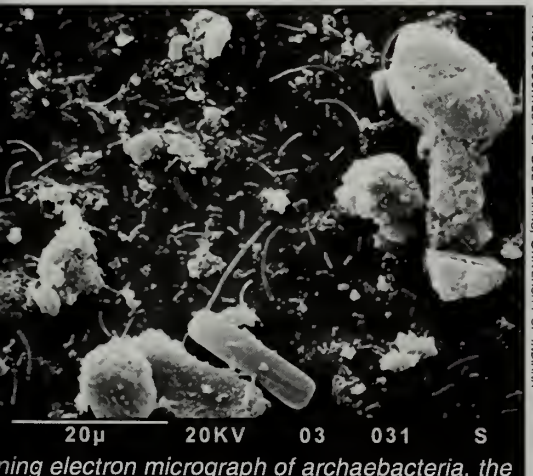
The 4-day conference delved into the state of the art of research into Yellowstone microbial resources, the colorful prokaryotic inhabitants of the Yellowstone geothermal ecosystem. Attended by 110 scientists from around the world, the conference brought together micro- and molecular biologists whose primary focus is thermophilic (heat loving) microorganisms and their heat-stable enzymes, the protein macromolecules that make up the building blocks of life. A conference publication, being prepared by the American Society of Microbiology, will serve as a milestone, updating modern thermophilic research and synthesizing NPS management options towards commercial development of research specimens.

The keynote address by Dr. Thomas Brock, an introduction to modern Yellowstone microbiological research, included his story behind the 1966 discovery of *Thermus aquaticus (Taq)*. This was the first life-form detected growing above the known upper temperature limit for life, then believed to be 72° C (162° F) . A heat-stable enzyme from this organism, *Taq* DNA polymerase, was essential in establishing the polymerase chain reaction (PCR) process. This DNA amplification technique revolutionized DNA science and earned its inventor, Kary B. Mullis, a Nobel prize in 1993. The gene expressing *Taq* polymerase was removed from specimen YT1-25104 (Yellowstone Type 1, deposited in the American Type Culture Collection as sample 25104) and inserted into *E. coli* ("microbial livestock") producing a genetically engineered organism called pLSG1. Polymerase chain reaction made possible a quantum leap in the DNA diagnostics industry including forensic analysis and detection of any type of DNA based disease; it grosses $200 million per year for the patent holder, Hoffmann-LaRoche, a Swiss pharmaceutical company. According to David Gelfand (see photo this page), codiscoverer of PCR, in his presentation on DNA polymerase, "PCR generated revolutions within the revolution" in molecular biology by providing new tools in amplifying DNA. O.J. Simpson's PCR evidence, and Michael Crichton's Jurassic Park scenario are spin-offs of how PCR could be used to make millions of copies of DNA. Medical technology is perhaps the greatest beneficiary of PCR. For example, Amplification of the Human Immunodeficiency Virus (HIV) DNA provides the only reliable early detection of AIDS. Polymerase chain reaction allows scientists to create any quantity of any type of DNA at will, opening up to humankind what until now has been the elusive domain of fundamental natural processes.

Biological diversity represented in the Yellowstone thermophiles is of special interest to biotechnology companies. Since microbes can perform most biochemical reactions known, their enzymes are used in manufacturing chemicals, antibiotics, plastics, detergents, and fermentation products. The recent development of heat-stable enzymes is increasingly important to such companies as Lily,

Exxon, E.I. DuPont, Roche Molecular Systems, and the dozen others with representatives attending the conference. Thermostable enzymes lend themselves to vast industrial processes and are less susceptible to denaturation than their mesophilic (body temperature) counterparts.

A good example of what national parks contribute to society is habitat protection and resulting preservation of biological diversity. In the case of thermophiles, conservation has yielded great utilitarian value in the enzymatic diversity that has been preserved, inadvertently, along with the geological curiosities and wonders for which the park was established in 1872. The Yellowstone geothermal ecosystem consists of the world's greatest concentration of thermophilic biodiversity in its 10,000 thermal features, and the companies want to contribute to the preservation of this unique biosphere reserve. They discussed voluntary contributions, royalties, foundations, and user fees as means by which companies could financially support National Park Service resource management efforts. Such funding could sponsor public and legislator education (through interpretive presentations) as to the value of maintaining biological diversity. Biotech companies could also support political activism in lobbying for passage of conservation efforts such as the Old Faithful Protection Act, which would prohibit geothermal drilling activities within 15 miles of the park boundary.



ning electron micrograph of archaebacteria, the primitive life-form yet discovered, collected a Hayden Valley hot spring.

PHOTO COURTESY OF SUE BARNS, UNIVERSITY OF INDIANA

A full day of presentations and round table discussions centered on the management of publicly owned resources and included active audience participation. The National Park Service does not encourage commercial development of natural resources within its jurisdiction. If, however, during the course of investigation, researchers make a commercially significant discovery, a means of sanctioning that discovery is now available through their research permit agreement with the superintendent and according to ongoing revisions in the Code of Federal Regulations. Intellectual property rights, patenting organisms, their products, and genes, trade secrets, and material transfer agreements are all issues related to research specimens that participants also addressed in their presentations and discussions. The symposium failed to reach consensus on royalties from profitable discoveries but did initiate a workshop entitled "Conservation and sustainable use of thermophilic microbial biodiversity at Yellowstone National Park: consensus building initiative" being conducted at the National Biodiversity Institute (Instituto Nacional Biodiversidad or INBio) of Costa Rica, January 20-27, 1996.

Thomas Lovejoy, science advisor to the Secretary of the Interior, spoke of Yellowstone thermophiles as "environmental extremists." Living in the extremes of temperature and pH, thermophiles clearly point out the importance of preserving biological diversity. He spoke of the biotechnology age (the interface of technology and biodiversity) where, through use of modern research, tremendous wealth is generated, exemplifying the utilitarian value of species preservation. He implied that in this era of hyperextinction, if we cannot preserve biodiversity for the obvious ethical reasons, then we should preserve it for the potential unknown benefits to humankind, such as the polymerase chain reaction.

During his presentation, "The Biological Wealth of Nations," Dr. Lovejoy also introduced the concept of INBio, the Costa Rican quasi-government organization that funds biodiversity preservation through private sector cooperative agreements. In exchange for access to Costa Rican National Park genetic resources (and excellent public relations), companies such as Merck Pharmaceutical and Bristol-Meyers invest large sums on rain forest preservation. Although distinct, INBio has evolved a biodevelopment track record Yellowstone could draw upon in respect to thermophiles. Indeed, Ana Sittenfeld, Director of Biodiversity Prospecting at INBio, gave a presentation on this issue and offered to share their experience, a wealth of details, on how to manage microbial resources in Yellowstone. In a presentation on high-tech molecular approaches to assessing biodiversity, Eric Mathur, Director of Recombinant BioCatalysis, Inc., of La Jolla, California, linked resource preservation to private industry in these days of public fiscal austerity by saying that "if industry does not support preservation of biodiversity, it probably won't happen."

Natural history presentations of thermophiles included an outline by Dave Ward of Montana State University on microbial ecology and the impacts of increasing numbers of researchers on bacterial mats. Since the small samples (a few milliliters) needed to start tissue culture collections are usually gathered with tweezers, and since the high growth rates of thermophiles revegetate disturbances quickly, no long-term harm to the resource is apparent. Human impacts are monitored closely by resource managers who emphasized that the research community must police itself with respect to minimal sampling and minimal impact to the system. Research permits are granted on a yearly basis on the premise that "no harm" to the resource will result from the research.

Other presentations included newly discovered species by Jurgen Wiegel and Beverly Pierson. Their work is being included in the NPS database known as the

Continued in column 3 on page 19

YELLOWSTONE PREDATORS DRAW A BIG CROWD

BY NORM BISHOP

THE THIRD BIENNIAL Scientific Conference on the Greater Yellowstone Ecosystem was held at the Mammoth Hot Springs Hotel from Sunday, September 24 through Wednesday, September 27, 1995. Entitled "Greater Yellowstone Predators: Ecology and Conservation in a Changing Landscape," the conference was attended by more than 200 researchers, managers, and the public.

Monday morning, Superintendent Mike Finley welcomed the conferees, and in his opening remarks highlighted the need for all researchers and managers to take an active role in educating the public on how nature really works. His examples included the roles of fire and predators in natural ecosystems. Dan Janzen illustrated his keynote talk on the role of predation in ecosystems with three stories spanning Asia, Australia, the Serengeti, and the New World. Nine speakers then addressed multiple species interactions, from lake trout and cutthroat trout, to red foxes and coyotes, to complex communities of carrion beetles.

At the Superintendent's international luncheon, keynote speaker Stephen Herrero, author of the well-known book *Bear Attacks: Their Causes and Avoidance,* spoke on the topic of "wild love"–the dedication and commitment to the wild that he sees as a common characteristic in wilderness and wildlife researchers throughout the world. Following lunch, four speakers addressed behavior of predators, from mountain lion killing methods to helping behaviors of coyotes to restored wolves. Then a session of natural history addressed a variety of species: ravens, tiger salamanders, mosquitoes, and midsized carnivores (lynx, wolverines, fishers, and martens). Scientists discussed techniques of inventorying and monitoring carnivores, and detecting rare or difficult-to-observe midsized carnivores.

PHOTO BY KERRY MURPHY, HORNOCKER WILDLIFE RESEARCH INSTITUTE

Yellowstone researchers radio collared this large male mountain lion in the Paradise Valley, north of the park, as part of a long-term cougar population dynamics and social ecology study that they reported on at the conference.

At a special wolf update session on Monday evening, Yellowstone wolf project leader Mike Phillips presented an overview of the current status of wolf recovery in Yellowstone, and then introduced cinematographer Bob Landis, who showed his footage of the newly arrived Yellowstone wolves interacting with coyotes, grizzly bears, elk, and bison.

The Tuesday morning keynoter, Steve French, M.D., shared recent applications of molecular DNA techniques to predator ecology, systematics, and conservation, especially that of bears. The topic then turned to conservation biology and management with nine speakers discussing management of grizzly bears, gray wolves, and midsized predators. Three speakers addressed social science: pelican control in early NPS policy, the economic value of Yellowstone trout, and changing public attitudes toward wolves. Two speakers treated physiological ecology: energetics in marten, and nutritional ecology of bears. Others discussed population dynamics and ecology with two talks relating to bald eagles and one to the influence of ungulate carrion on coyote behavior and demographics.

The first two very busy days of the conference concluded with the poster session, the evening banquet, and the presentation of the A. Starker Leopold Lecture. Posters, which were displayed for most of the conference, were presented on 11 topics, ranging from aquatic insect predators to a test of the attractiveness to bears of the alternative snowmobile fuel rape ethyl ester. World renowned wolf biologist L. David Mech presented the A. Starker Leopold Lecture, "The Value of Long-term Carnivore Studies in National Parks." The proceedings of the conference will be published with details to be printed in the quarterly *Yellowstone Science.*

On Wednesday, both the National Park Service and the Northern Rockies Conservation Cooperative co-hosted a special symposium, "Carnivores in Ecosystems." This symposium featured a series of invited speakers exploring carnivore topics at greater length (only the authors who spoke follow, though many had coauthors). University of California, Santa Cruz, Assistant Professor Steve Minta introduced the symposium with a discussion of Yellowstone as a model system for understanding carnivores, and asking, "Is There a Theory of Carnivore Ecology?" Moderator and Yellowstone Center for Resources Director John Varley

ntroduced the morning session on greater Yellowstone carnivores. *Yellowstone Science* Editor Paul Schullery traced the history of carnivores in the Yellowstone region, Wildlife Biologist Frank Singer quantified he carnivore prey base, and Interagency Grizzly Bear Study Team Leader Dick Knight said the bear population is showng signs of saturation in Yellowstone National Park and that we need to learn ow better to manage people in the Yelowstone area. Lion researchers Ian Ross nd Kerry Murphy spoke on their respecive cougar studies (see photo), and U.S. ish and Wildlife Service Biologist Ed Bangs listed the big issues in wolf restoation, including their feared impacts on vestock, big game hunting, and public and use practices. Coyote researcher Bob Crabtree listed studies of sympatry beween coyotes and wolves, and between oyotes and red fox, showing temporal voidance in the latter two. Zoology proessor from the University of Wyoming teve Buskirk revealed how nesopredators (small mammals of a few ounds or less) are important aesthetically nd spiritually, affect prey populations, cavenge, disperse seeds, and structure opulations of nonprey species, including ach other.

The afternoon session, entitled "The Utility of Experimental Research for Ecological Theory, Conservation, and Management," focused on theoretical issues. Fred Allendorf, University of Montana Professor and biologist, explored genetic onsiderations–interbreeding, crossbreedng, and inbreeding–as they affect restoation and management of predators. ackson Hole elk herd expert Mark Boyce ssessed models for conservation and nanagement. Steve Minta spoke on refousing experimental questions and scales, nd offered recommendations for research nd management. Minta and conservaion biology author Michael Soule assessed carnivore recovery and onservation in North America. The sesion was summarized by Tim Clark, Dector of the Northern Rockies Conservation Cooperative), with final remarks by John Varley. Symposium organizers also intend to publish these papers in book form with *Yellowstone Science* also carrying news of that publication.

The fourth conference in this series will be held in 1997. In recognition of the 125th anniversary of the creation of Yellowstone National Park, which will be celebrated that year, this conference will focus on people and their role in greater Yellowstone. Announcements will be forthcoming in about 8 months.

Norm Bishop is the Natural Resources Interpreter for the Yellowstone Center for Resources. He can be reached at (307) 344-7381.

THE SECOND ANNUAL WILDLIFE SOCIETY CONFERENCE SETS RECORDS

BY MICHAEL COFFEY

A RECORD SETTING 2,100 wildlife biologists, managers, administrators, natural resource leaders, and students attended the second annual conference of the Wildlife Society last September in Portland, Oregon. The conference, "Excellence in Wildlife Stewardship through Science and Education," provided a wide range of topics relevant to the theme and included 19 symposia, 44 sessions, and over 400 papers and poster sessions. Both symposia and contributed papers and posters were grouped by subject matter and, other than the plenary session, ran concurrently. Field trips, associated meetings, and a wide variety of special activities provided opportunities for participants to visit and renew old or make new acquaintances.

The plenary session addressed "Long-term Research on Keystone Species: Implication for Ecosystem Management." Five outstanding speakers fleshed out the symposium. Jack Berryman, the Wildlife Society's 1995 Aldo Leopold Award Recipient, provided opening remarks with James A. Estes of the National Biological Service, who discussed the sea otter in nearshore marine communities following. E. Charles Meslow, the western regional representative of the Wildlife Management Institute, addressed the role of the northern spotted owl in late successional forests, and Samuel J. McNaughton of the University of Syracuse, New York, Biological Research Laboratories examined grazing ungulates in African savannas. H. Ronald Pulliam, Director of the National Biological Service, provided a perspective on human populations and global ecosystems.

The Wildlife Society decided to hold its own conference 2 years ago in part to provide a forum for working field biologists and managers to exchange information. With the vast amount of wildlife management and research activities conducted throughout the national park system this forum is an excellent opportunity for field people to share and present information. Somewhat of a disappointment, however, was the small number of papers reporting research and management activities in the national park system and the small number of National Park Service personnel in attendance. It is time to get our message out to our peers, exchange information, and participate in the wildlife community.

Mike Coffey is a Wildlife Biologist with the Natural Resource Partnerships Program Office of the National Natural Resource Program Center in Fort Collins, Colorado. His phone number is (970) 225-3553.

Internet continued from front page

puters is cc:Mail. If this is the case, many of the high-powered, fast, multimedia aspects of the Internet will not be available to you. But that is no reason to put off acquiring useful job-related information and developing professional contacts over the Internet.

What is the Internet?

Bob Rankin, author of *Accessing the Internet by e-mail: Dr. Bob's guide to offline Internet access,* defines the Internet as a sprawling collection of computer networks that spans the globe, connecting government, military, educational, and commercial institutions and private citizens to a wide range of computer services (other Internet definitions can be found on page 17). He elaborates that a set of network conventions and common tools is employed to give the appearance of a single large network, although the linked computers actually use many different hardware and software platforms. With more than 3.5 million computers and 40,000 computer networks, the Internet (Net for short) was born of an experiment in postnuclear war command communications by the U.S. Department of Defense in the 1970s. The effort eventually grew to include the National Science foundation and several universities and advanced from there.

Uniform Resource Locators

To get information over the Internet you need to know the computer and directory in which the information resides. These two pieces of information essentially comprise an address for the information. When these two pieces of information are preceded by an abbreviation for a specific type of resource (usually "gopher" or "http"), the string of characters is called a Uniform Resource Locator (URL).

Examples of URLs are:

http://bluegoose.arw.r9.fws.gov/FWSHomePage.html

gopher://huh.harvard.edu/11/collections_info/aa

It is important to remember that the difference between upper and low case letters is important in URLs, unlike with e-mail addresses. But don't worry: as with all computer systems, if you make a mistake in typing the URL, be assured that you will get an error message.

Access to Internet by E-mail

Webmail and Gophermail are two ways you can retrieve information using only e-mail, the lowest level of Internet connectivity (see sidebar). Others, e.g., FTPmail, Finger, Archie, Veronica, Usenet, and Wais, will almost certainly be created in the future.

Even cc:Mail users can retrieve the text portions of Web pages by using a service known as Webmail.

Webmail

In the past 3 or 4 years, a system of moving information between computers on the Internet was created called the World Wide Web. Unlike e-mail, which moves only text-based information across the Net, the World Wide Web (the Web or simply WWW for short) can interactively move sound, moving images, still images, and text. The multimedia documents being produced these days, with embedded links to other computer documents, are known as web pages or hypertext documents. Not all Internet computers can deliver the web pages that are now the state of the art. However, even cc:Mail users can retrieve the text portions of these more sophisticated hypertext pages (without ever seeing them) by using a service known as Webmail. The service is available at four Internet addresses (that I know of):

webmail@www.ucc.ie
webmail@curia.ucc.ie
agora@w3.org (out of service, temporarily)
agora@www.undp.org

A request for a Web page returns only the text portion of the document. While the sounds, images, and movies are not returned, the URLs for links to other Web pages are returned. These URLs can then be used to retrieve additional documents. Using cc:Mail the steps are as follows:

(1) select "Address to person" [enter]
(2) select "np—Internet" [enter]
(3) type one of the Webmail addresses given above [enter]
(4) select "End addressing" [enter]
(5) type a subject line (optional)
(6) in the message body, type "go" (if using one of the Webmail addresses) followed by a URL. Alternatively, use the word "send" followed by a URL if using one of the agora addresses.
(7) F10
(8) send message

Levels of Connectivity

E-mail Gateway Accessing the Internet through a gateway, usually to send or receive e-mail, is the lowest level of connectivity. For example, a NPS cc:Mail user may send a message through the gateway ("NP--INTERNET" on the cc:Mail address list) to any e-mail address, e.g., "stephen_fettig@nps.gov". The gateway computer controls the flow of information between one computer network and the rest of the Internet and forwards the message. The specific type and method of information transfer is determined by those who administer the gateway computer.

Modem Connecting to the Internet by modem is the most common method. At this level a user runs programs (clients) located on another computer (host), which connects to the Internet. Access to the Internet is limited by the client programs, which the system administrator places on the host computer. On-line services, such as Prodigy or Compuserve, are popular examples of commercial hosts.

Direct Connection A full, 24-hour, hardwired connection to the Internet is the highest and most costly level of connectivity. With a minimum price tag of around $30,000 per year, this option is usually limited to large organizations and universities.

Web pages that I have found useful are:

http://Internet.edu/about/scientis/menu.htm
A list of scientists working on Long-term Ecological Monitoring Network (LTER) projects and links to other LTER information;

http://www.nfrcg.gov/home-page/htmls.html
A National Biological Service site that gives many links to Internet resources for biologists;

http://bluegoose.arw.r9.fws.gov/FWSHomePage.html
The U.S. Fish and Wildlife Service home page;

http://www.nwi.fws.gov/Welcome.html
Information on the National Wetlands Inventory with several links to other WWW resources;

http://nmnhwww.si.edu/departments/vert.html
Information on the vertebrate zoology department at the Smithsonian Institution Museum of Natural History;

http://nmnhwww.si.edu/nmnhweb.html
The home page for the Smithsonian's natural history museum;

http://straylight.tamu.edu/bene/bene.html
The site of the Biodiversity and Ecosystems Network webserver. This is one site where you can learn of e-mail lists related to biodiversity topics;

http://florawww.eeb.uconn.edu/FAM_DESC/_fdlist.htm
An index of detailed plant family descriptions

By following other URL links you can, for example, retrieve family descriptions of the Rubiaceae at...

http://florawww.eeb.uconn.edu/fam_desc/Rubiacea.htm

or the Ericaceae at...

http://florawww.eeb.uconn.edu/fam_desc/Ericacea.htm

http://www.aps.edu/HTMLPages/WERP.html
Background information on the New Mexico Museum of Natural History Water Ecology Research Project;

http://envirolink.org/enviroweb.html
Links to many Web pages, including the Endangered Species Act On-Line, Environmental Legal Documents, and the Frog Information Server;

http://ash.lab.r1.fws.gov/usfwslab.html
Links to many wildlife related Web pages, including summaries of natural resource protection laws, such as the Lacey Act, the Migratory Bird Treaty Act, the Endangered Species Act, and others. A link to a list of endangered species is also included;

http://envirolink.org/florida/other.html
South Florida environmental resources; and

http://www.satelnet.org/manatee/facts.html
Facts about manatee biology and natural history.

Gophermail

Gopher provides menus or indexes of available text information in list form. It was named after the Minnesota Golden Gophers of the University of Minnesota where the software was first created. Items in each list are either titles for other menus or names of text documents. Menus do not just apply to one computer. Rather, a Gopher menu on a computer in Seattle, Washington, may have list information for dozens of computers around the world.

To get a Gopher menu, send an e-mail message to one of the following addresses:

gophermail@calvin.edu
gopher@ucmp1.berkeley.edu
gopherm@mercury.forestry.umn.edu
gopher@pip.shsu.edu
gopher@solaris.ims.ac.jp
gophermail@ncc.go.jp

Using cc:Mail, the steps are as follows:

(1) select "Address to person" [enter]
(2) select "np—Internet" [enter]
(3) type one of the addresses above [enter]
(4) select "End addressing" [enter]
(5) type a subject line (optional)
(6) type "help" in the message area
(7) F10
(8) send message

If you have a specific gopher URL that you want to reach (such as *"gopher://sunsite.unc.edu/1m/../.pub/academic/biology/ecology+evolution/bioguide/bioguide.item"*), use one of the Webmail addresses from the table or place the computer host name in the subject line, as follows:

gopher.micro.umn.edu
Main gopher menu at the University of Minnesota;

muse.bio.cornell.edu
Biodiversity and biology menu at Cornell University;

biodiversity.ups.edu
Another biodiversity gopher menu;

gopher.epa.gov
Environmental Protection Agency Gopher menu; and

marvel.loc.gov
Library of Congress.

Gophermail will return a menu. When you select a document by placing an "X" before the document name and return the message to Gophermail, that document will be sent to you. Whereas items that will take you to additional menus end with a forward slash ("/"), document names do not. By selecting a menu name with an

Continued on page 18

Selected Internet Definitions

Archie	A computer information system that searches for documents, images, sound files, and software at anonymous FTP sites based on key words supplied by a user.
cc:Mail	E-mail software used by the National Park Service, some universities, and other groups.
Client	Software that resides on a local computer and is used to retrieve or view information on other computers on the Internet. To use Archie you need an Archie client; to use Gopher you need a Gopher client.
Cyberspace	All or any functioning subset of computers, computer networks, and software that are interconnected. The word connotes the existence of electronically created environments used for entertainment or communication that appear to have little or no relationship to their physical locations.
E-mail	A general term for any text-based electronic communication between computers. Cc:Mail, Popmail, and Pine are examples of e-mail software (clients).
FTP	File Transfer Protocol. A system for transferring either text or binary data between computers. Anonymous FTP sites allow access without using a confidential password.
Gopher	A program for viewing directories and getting text information from computers, which are set up as Gopher servers. Using Gopher requires a Gopher client (software).
Server	A computer specially set up and administered to provide information (data or software) to other computers. Servers can provide any combination or subset of Gopher, Archie, Veronica, FTP, World Wide Web, e-mail, or other services.
URL	Uniform Resource Locator. The string of characters used to identify files by resource type, directory, and computer anywhere in the world.
Veronica	A computer information system that searches for documents, images, sound files, or software at Gopher sites based on key words supplied by a user. Veronica is to Gopher as Archie is to FTP.
The Web	The World Wide Web. Collectively, the computers (servers) that are set up to provide interactive and interlinked multimedia documents over the Internet. Whereas the e-mail function of the Internet only allows messages to be sent one way and is limited to text, the web is interactive and allows users to browse through documents that contain text, images, sounds, and movies.

Continued

"X" and sending the message, Gophermail will connect to the appropriate computer anywhere in the world and give you a new menu. That can be done iteratively until you give up, or find the information you are looking for. Because there are no rules as to which computers hold which information, you may find the same information on several computers, or you may not find what you are looking for.

Caution

Accessing the World Wide Web using e-mail is a lot like getting a transcript of a television program by U.S. mail: you get text and stage directions, but no images or sounds. Often the message needs reformatting. The servers providing these access services get extremely heavy use. Thus, expect a full day or more for a response. If you do not get a response in 4 or 5 days, resend your request. It helps to avoid sending requests during regular business hours when Internet use is staggering at many sites. Consider sending your requests at the end of your work day or at the end of a work week, so the server can process the request overnight or over a weekend. If you are at a site where the telephone lines give cc:Mail problems when large messages are delivered, consider sending only one request at a time. Reply messages are frequently more than one page and can often be several pages. Finally, these Internet-by-e-mail services are provided free of charge to all Internet users, worldwide, but can be costly to the providers. Thus, changes, cancellations, and interruptions to the services can and do occur.

Steve Fettig is a NPS Biologist stationed at Bandelier National Monument, New Mexico. You may have guessed that his e-mail address is "stephen_fettig@nps.gov".

E-lists and Listservers

E-LISTS, OR LISTSERVERS, ARE electronic mail distribution lists. They can be two-way or outgoing only. With the two-way lists, subscribers can post messages to the list at any time and the messages will be automatically distributed to all subscribers. Outgoing lists are like electronic news periodicals. The owners and operators of outgoing lists are the only ones who can post messages to all subscribers.

The Environmental Protection Agency (EPA) offers several very useful outgoing lists. The following lists are distributed from the *Federal Register* on the day of publication.

Listserver Name	Description
EPA-Meetings	*All meeting notices*
EPA-Impacts	*All environmental impact statements published in the* Federal Register
EPA-Species	*All endangered species documents published in the* Federal Register
EPA-Pest	*All Office of Pesticide Program documents*
EPA-Waste	*All hazardous and solid waste documents*
EPA-Water	*All Office of Water documents*

To subscribe to any of the above lists, address a message to:
listserver@unixmail.rtpnc.epa.gov

Your message should contain only the following one line:
subscribe <listserve-name> <Your first name> <Your last name>

For more information and additional listserve names, descriptions, and commands send a note to the above listserver address with "Help listserver" as the message.

Be aware that each listserve may distribute between zero and ten messages per day. Some documents are long and will be split into several messages. To avoid being overrun by messages, you will need to learn to quickly delete many messages. I delete 90-95% of the messages within a few seconds. One very annoying problem with these lists, however, is that the subject lines given in each message are usually worthless. But otherwise the lists are very useful and provide Federal Register information very quickly.

Internet guides available by e-mail:

Rankin, Bob. 1995. Accessing the Internet by e-mail: Doctor Bob's guide to offline Internet access. 4th edition, July 1995. 31 pages.

Send e-mail to "listserv@ubvm.cc.buffalo.edu". Leave subject blank and type only this line in the message area: "get internet by-email nettrain f=mail".

Or retrieve from: "webmail@curia.ucc.ie"

The one-line message should be:

"go gopher://sunsite.unc.edu/1m/../.pub/academic/biology/ecology+evolution/bioguide/bioguide.item"

Smith, Una R. 1993. A biologist's guide to Internet resources. 30 pages.

Send e-mail to "agora@w3.org". On one line, place the following message:

"send gopher://sunsite.unc.edu/1m/../.pub/academic/biology/ecology+evolution/bioguide/bioguide.item"

Yanoff, Scott. 1995. Yanoff's list. 37 pages.

Send e-mail to "inetlist@aug3.augsburg.edu". The server will automatically reply with a blank message.

MAB e-mail group continued

sustainability; developing proposals that support cooperation, innovation in conservation, ecosystem management, and use; submitting proposals for new biosphere reserves and additions to existing biosphere reserve and regional MAB cooperatives; and (3) announcements of conferences and upcoming meetings.

To subscribe to the USMAB e-mail discussion group, send an e-mail message to the address: "listproc@ucdavis.edu". In the body of the message (you can leave the subject line blank as it will be ignored by the computer) type:

"subscribe usmab_program <firstname> <lastname>",

where you insert your first name and last name. For example, type: "subscribe usmab_program John Smith". To send a message to all USMAB program participants, send an e-mail to:

"usmab_program@ucdavis.edu".

To unsubscribe from the usmab_program e-mail listserver, send a message to: "listproc@ucdavis.edu". In the body of the message type: "unsubscribe usmab_program".

For more information about the U.S. Man and the Biosphere Program; contact Roger Soles; United States Man and the Biosphere Program; OES/ETC/MAB, 1st Floor SA-44C; United States Department of State; Washington, D.C. 20522-4401; phone (202) 776-8318; fax (202) 776-8367 *or* Jennifer Gaines; U.S. Department of Interior; National Biological Service; 1849 C Street, NW MS 3070; Washington, DC 20240; phone (202) 208-1687; fax (202) 208-7275; "jennifer_gaines@nbs.gov".

PS

Inquiries about the operation of this e-mail group may be addressed to James F. Quinn; Division of Environmental Studies; University of California, Davis; Davis, CA 95616; "jfquinn@ucdavis.edu".

Partners in Flight continued

Wildlife." The funding initiative promotes an "outdoor enthusiasts" user fee on a range of outdoor equipment (such as backpacks, tents, mountain bikes, recreational vehicles, photographic equipment, bird seed, and field guides). It aims to raise $350 million annually to fund "wildlife diversity programs." The proposed fee is similar to the fees that hunters and anglers have been paying for more than 50 years to support game and sport fish conservation programs. The funds would be allocated to states using a formula similar to that used to distribute Dingell-Johnson, Pitman-Robertson, and Wallop-Breau funds for game and fish management programs. Under this proposal, states must provide 25% of project costs and federal agencies are not eligible for funds. However, projects funded under the program could be conducted on federal lands.

Teaming with Wildlife funds would be devoted entirely to nongame species management. The initiative is already endorsed by more than 300 different groups including several companies whose products would be assessed. Reportedly, Speaker of the House of Representatives Gingrich expressed support for a user fee (as opposed to a tax) to support nongame conservation. "Teaming with Wildlife" seems to have momentum and could soon provide funds for land bird conservation (and nongame conservation overall) at a time when funds are desperately needed.

To date, Partners in Flight has stimulated interest and action promoting conservation of migratory birds. The primary benefits have arisen through communication and increased awareness among diverse PIF partners. Concrete examples of conservation action already exist in areas like the Mississippi Alluvial Valley. If successful, the International Partners in Flight Conservation Plan will provide a tool to stimulate conservation on scales (ecosystem, regional, national, and international) that are ecologically meaningful for migratory birds.

PS

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Yellowstone thermophiles continued

thermophilic microorganism survey, a baseline inventory of these species which is being established on the World Wide Web. Other topics included physiology, distribution, evolution and techniques used to study these enigmatic creatures, most of which cannot be grown in tissue culture.

The symposium generated suggestions on how we might proceed with the Yellowstone microbiology program. They included the establishment of an independent blue-ribbon panel of senior scientists connected via an Internet list server. Representing the three constituencies of academia, industry and resource management, the expert panel could suggest solutions to commercial use issues, review technical material concerning research permits, develop or review protocols for field researchers working in the geothermal ecosystem, and provide insight into the long term preservation and management of this national treasure.

The symposium drew to a close with a field trip led by Dr. Brock to Black Sand Basin, within walking distance from Old Faithful. It was made clear that the private sector is enthusiastic about working with the NPS in formulating strategy on the preservation and maintenance of thermophilic biodiversity in Yellowstone National Park. With an estimated 99% of Yellowstone's thermophiles yet undiscovered, according to Norm Pace of Indiana University, who developed a new way of detecting enigmatic species called "phylogenetic analysis," our 40 ongoing microbiology research projects have much work to look forward to.

As with many other issues in conservation biology, Yellowstone has a long history of setting precedents. To me, the National Park Service conference organizer, the end of this symposium marks the beginning of the Yellowstone Microbiology Program, an initiative to preserve, protect, educate and attract funding for the benefit of all participants interested in this nontraditional, superheated field of resource management.

PS

Bob Lindstrom is Management Assistant with the Yellowstone Center for Resources. His phone number is (307) 344-2234.

Cooperation Enhances Revegetation Efforts in Glacier National Park

By Raymond C. Shearer, Rachel W. Potter, Laurie L. Kurth, Jennifer M. Asebrook

Figure 1. A researcher shows one of the seed traps used in the study to catch and measure seedfall.

The scenic Going-to-the-Sun Road in Glacier National Park, Montana, is currently being reconstructed. Several cooperating agencies, including the Federal Highway Administration, U.S. Department of Agriculture, Forest Service (Intermountain Research Station), Natural Resources Conservation Service (formerly the Soil Conservation Service), and the National Park Service participated in the construction and revegetation planning efforts that began in the mid-1980s. Provided for in the 1982 National Surface Transportation Assistance Act, road rehabilitation began in 1991. However, initial revegetation planning for the 16 km (9.8 mile) Lake McDonald section of the road was hampered because information regarding natural regeneration by conifers and revegetation success of several native herbaceous species was lacking.

Research was needed to determine the best way to restore native vegetation to the disturbed road corridor while providing adequate soil stability and minimizing the number of invasive exotic species. Study sites were established in both Glacier National Park and the nearby Coram Experimental Forest (administered by the Intermountain Research Station and located on Flathead National Forest), two biosphere reserves, which are units of the United Nations Program on Man and the Biosphere. The two areas combine a large natural park managed for ecosystem conservation (Glacier National Park) with a field research site (Coram Experimental Forest), a beneficial pairing for the needed revegetation research. The common biosphere reserve designation stimulated cooperation between personnel at both reserves to study dispersal and viability of conifer seedfall and planting of native species for revegetation.

Objectives

A dense conifer forest canopy paralleled the road, and we expected that most, if not all, disturbed areas would quickly regenerate with conifers. The purpose of the conifer seedfall study was to estimate by species the number of conifer seeds that (1) dispersed from cones maturing from 1987 through 1995 above and below the road, (2) germinated on cut slopes from 1992 (the first year after treatment|) through 1996, and (3) produced surviving seedlings through 1996.

Research on planting native species required a recent road cut. To minimize disturbance from the study in Glacier National Park, we chose a comparable site on Coram Experimental Forest to determine if (1) seeding with native forbs and grasses could provide a stable cover and reduce volunteer exotics or if a rapidly growing agronomic mix would be necessary, (2) fertilizer presence or timing would benefit natives or exotics, (3) specific native species would establish from seed, and (4) seeding or transplanting would be a better way to establish pinegrass *(Calamagrostis rubescens)* and beargrass *(Xerophyllum tenax)*.

Study Areas and Methods

The seedfall study is located along the Lake McDonald section of the road within Glacier National Park. This section lies along the 975 m (3,200 ft) contour within the western red cedar *(Thuja plicata)*-western hemlock *(Tsuga heterophylla)* forest type (Eyre 1980), and is composed mostly of stands originating after fires in 1735 (Barrett 1988). Other conifers within this predominantly cedar-hemlock forest are Douglas-fir *(Pseudotsuga menziesii)*, western larch *(Larix occidentalis)*, spruce (probably hybrids of Engelmann *[Picea engelmannii]* and white spruce *[Picea glauca]*), lodgepole pine *(Pinus contorta)*, western white pine *(Pinus monticola)*, and subalpine fir *(Abies lasiocarpa)*. Seedfall from the conifer trees was estimated along the road using forty 0.4 m^2 (4.4 ft^2) seed traps (fig. 1). We positioned two seed traps about 15 m (50 ft) apart above the road cut and also below the road fill at each of 10 locations. Contents of the traps were emptied periodically after seeds began to disperse in early September each year. Time and amount of seedfall for each species was determined each year. Near each group of seed traps, four 0.25 m^2 (2.7 ft^2) plots were established in the new road cut to monitor germination of conifer seed and mortality of seedlings once a month from May through September beginning in 1992.

For the planting study, we chose a section of road in the Coram Experimental Forest for its similarity to the Lake McDonald road section. Research staff regraded approximately 2.5m (8.2 ft) of high cut slopes above the road. In the fall of 1987, crews installed ten treatments in 1 m^2 (10.8 ft^2) test plots, each with four replicates. Treatments on the cut slopes were (1) a native grass and forb seed mix (Table 1) that received (a) no fertilizer, (b) fertilizer at planting, and (c) fertilizer the spring after planting; (2) a control treatment with no seed or fertilizer, (3) pinegrass seed, (4) pinegrass rhizome sections, (5) beargrass seed, and (6) small beargrass transplants. We planted two treatments in the ditch using (1) the same native mixture as on the slopes, and (2) an agronomic mixture consisting of Kentucky bluegrass *(Poa pratensis)*, Canada bluegrass *(Poa compressa)*, and red fescue *(Festuca rubra)*. We measured percent of coverage, seedling density, and transplant size for 3 years following planting.

Results and Discussion

Conifers began to reforest cut and fill slopes the first year after treatment. Much of the seed that fell on cut slopes from a

poor cone crop that matured in 1991 washed into the ditch below in the spring of 1992 because there was no vegetation to hold it on the site during snowmelt and associated overland waterflow. Conditions improved the following years after vegetation established, holding more of the seeds where they fell. The amount of conifer seed dispersed varied greatly by species and year (Shearer and Potter 1994). During the study, over 90% of the seed fall, germination, and survival was western hemlock or western red cedar. Hemlock and cedar will be the major conifers to regenerate cut and fill slopes along the road naturally. Other conifer species will establish less frequently and provide diversity.

After three growing seasons, we summarized the results of the planting study at Coram. The unseeded control had higher cover of volunteer forbs and grasses and higher densities of volunteer forbs than the seeded treatments, indicating that seeding may reduce growth of volunteers, including weeds. In the ditch treatments, the agronomic mix had higher grass cover than the native mix but no significant difference in the number of volunteer forbs occurred. Results from the fertilizer study were inconclusive. The unfertilized treatment had the highest cover of seeded forbs and the lowest cover of volunteer forbs, but it also had the largest number of volunteer forb species, suggesting that its cover may increase in the future. Competition, resulting from a high grass seeding rate (1,830 seed/m^2), may have contributed to grass cover increasing the first 2 years and markedly decreasing thereafter. All seeded native species germinated and established satisfactorily, but cover of forbs and pinegrass was low (Table 1).

When pinegrass seeded by itself at 646 seeds/m^2, it had canopy cover of 49%; however, when seeded in the mix with faster growing species, its cover was only 5%. Although only 11% of pinegrass rhizome sections sprouted, they quickly produced vigorous, large plants. When beargrass was seeded by itself, 29% of seeds established the first year. This increased to 49% the second year and did not increase thereafter, indicating that many seeds required 2 years of cold stratification. Beargrass seeds planted in a mix had 22% establishment the first year and the numbers remained constant. Ninety-five percent of beargrass transplants survived and were larger in the third year than at planting. All mortality occurred in the first summer.

Based on these results, the park planned to seed along the road to provide quick cover, increasing native species and reducing exotics. We did not need to use an agronomic mix because native species provided sufficient cover. A very light fertilizer was applied at seeding to balance carbon content of the mulch. Seeding rates of early establishing grasses were decreased and pinegrass and forbs were increased. All available native species in the study were included on the road seed mix. We seeded pinegrass and beargrass rather than use the more labor intensive transplants, but we did not plant bluegrass as originally planned.

Results of revegetation along the Lake McDonald section of the road parallel those from the cooperative studies. Ninety percent of germinating conifers were western red cedar or western hemlock with other conifer species establishing less frequently. Native species canopy cover, especially seeded grasses, has increased each year and to date usually exceeds weed cover by 10-25%. In control areas that were not seeded, weed cover exceeded native cover by the same amount; this result supports the use of native seed to increase native species and reduce exotic cover. Both pinegrass and beargrass, seeded on the road with fast-growing species, were not observed until the second year after seeding. Presently, each species provides less than 1% cover but both continue to increase in frequency. From 1992-94, beargrass has increased in frequency from 0-40%, while pinegrass has increased from 0-5%.

ABLE 1.

MEAN CANOPY COVER OF SEEDED GRASSES AND ORBS AND MEAN ESTABLISHMENT OF SEEDED FORBS NATIVE MIX TREATMENTS IN THE CORAM STUDY URING THE THIRD GROWING SEASON. (NM=NOT EASURED)

pecies	Mean Cover (%)	Seed Establishment (%)
gropyron spicatum	4.8	NM
romus carinatus	41.7	NM
alamagrostis rubescens	5.4	NM
naphylis margaritaceae	2.9	34
ntennaria microphylla	<.1	35
ntennaria neglecta	<.1	14
rnica latifolia	4.4	91
ster laevis	7.1	>98
erophyllum tenax	<.1	25

SUMMARY

Work conducted in the experimental portion of one biosphere reserve has augmented protection of the core area of another biosphere reserve. The Man and the Biosphere Program promotes cooperative studies such as this, which enables input from several specialists and results in sound resource management decisions. Significant applicable information was obtained that the park could not have generated alone, due to the lack of subject expertise or ability to conduct manipulative experiments. Not only did Glacier National Park receive information that directed efficient and effective revegetation, but our basic silvicultural knowledge increased for several conifer species.

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Eyre, F.H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters. Washington, DC. 148 p.

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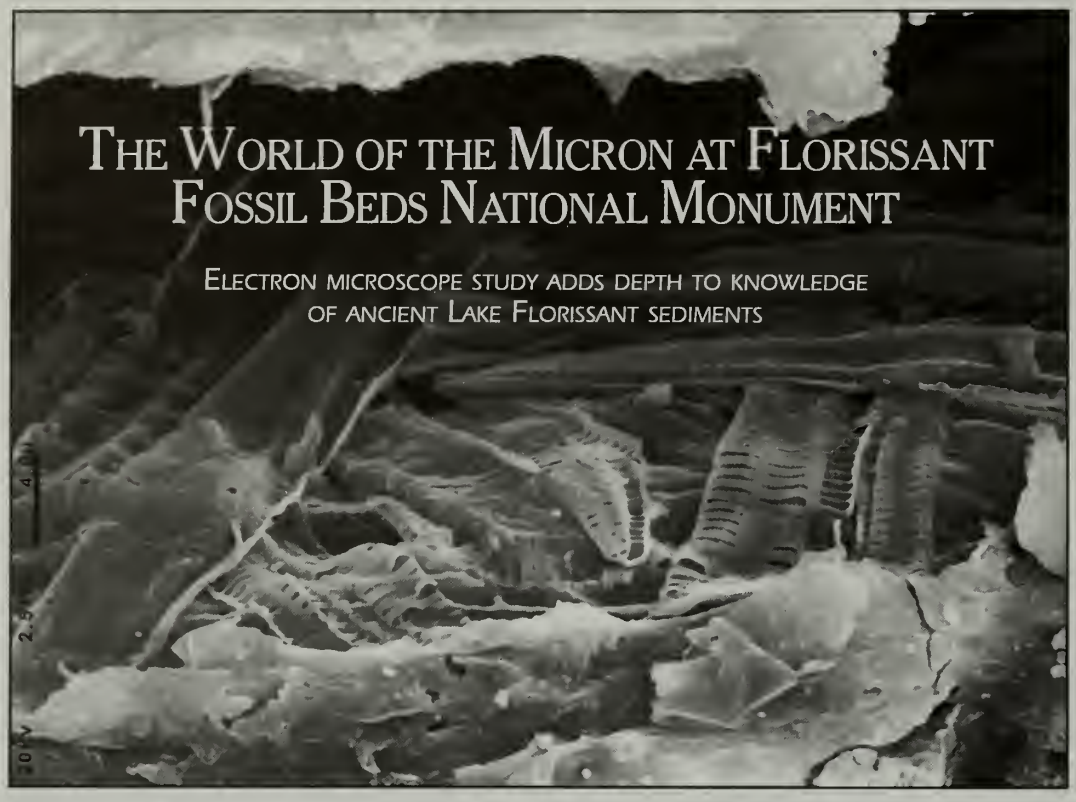
Ray Shearer is Research Silviculturist and Manager of Coram Experimental Forest, Intermountain Research Station. Rachel Potter is a former biosciences technician at Glacier National Park. Laurie Kurth is a former Ecologist at Glacier National Park and is now a Botanist at Zion National Park, Utah. Jennifer Asebrook is a biosciences technician at Glacier National Park.

The World of the Micron at Florissant Fossil Beds National Monument

Electron microscope study adds depth to knowledge of ancient Lake Florissant sediments



Note: *Scale for all figures shown in microns (millionths of a meter).*

Figure 1 (left). Scanning electron micrograph of a diatom mat.

By Neal R. O'Brien and Herbert W. Meyer

Lying in the shadow of Pike's Peak in the Rocky Mountains of Colorado is an ancient lake bed containing remarkably preserved fossil remains of plants, leaves, and insects at Florissant Fossil Beds National Monument. Since the early 1870s, the delicate fossilized remains of conifers and many species of broad-leaved plants have been found entombed in the sediment layers along with a variety of insects such as beetles, flies, wasps, dragonflies, and butterflies. Although over 300 publications describe the fossil content of this unique geologic deposit, only a few discuss the details of the geological history of the lake that existed in the area during the later part of Eocene epoch 34-35 million years ago. During the summer of 1995, with support from the National Park Service, we began an intensive geological investigation to examine minute details of the sedimentology and paleontology of ancient Lake Florissant using the scanning electron microscope. We want to know what happened 35 million years ago in Colorado.

An impressive feature of the lake deposits is the abundance of fine millimeter or less thick laminated sediments. Laminated sediments are common in many lake deposits where they often show a seasonal alternation of deposition. Previous study of the laminations in the Florissant area (McLeroy and Anderson 1966) revealed that the deposit contained alternating fine layers of volcanic debris (pumice and ash), diatoms, and organic rich matter called sapropel. They indicated that the lake water was stratified and that these fine laminae recorded episodic events occurring with the seasons.

We undertook a detailed investigation of the laminated sediments in order to understand the ancient sedimentary processes during lake existence and what might have caused the alternating or episodic events recorded by the thinly layered sediment. Using a scanning electron microscope, we hoped to find microscopic clues to the source of sediment and how it was deposited in the lake basin. Viewing the lake deposits at the scale of the micron has revealed a world of sediment and fossil features never before seen in such detail from the Florissant beds. Presented here are our initial results of photos showing some of the features in the unexplored microscopic world of Lake Florissant. Our study is continuing; however, these initial results show that there is another exciting aspect of the Florissant deposits in addition to previously described fossils.

Some very thin layers are composed entirely of the siliceous remains of diatoms belonging to a single species that bloomed in the lake water and accumulated on the bottom following a die-off. The diatom-rich layers indicated to McLeroy and Anderson (1966) clues of spring blooms occurring during the time when winter and spring runoff supplied abundant nutrients to the lake for diatom growth. Our view at the micron level shows a mat of randomly scattered diatom fossils arranged like bodies on a battlefield after a terrible massacre (fig.1). A more accurate interpretation would be that the haphazard arrangement of fossils is proof of diatom blooming, mass dying, and fairly rapid burial. Another species of the diatom (fig. 2, page 20) also is found in other layers, but it does not form mats. These two diatom types may have lived and died under different ecological conditions. Our future study will try to determine if changes in the ancient lake conditions had an effect on the type of life living in the water.

Other alternating millimeter thick layers contain ostracode shells embedded in volcanic ash sediment. The bean-shaped shells of this crustacean (like a shrimp) sometimes are large enough to be seen with a hand lens but often escape recognition. However, their microscopic shells are very common in certain layers when viewed with scanning electron microscopy (SEM).

The structures of spores and wood are also revealed in the world of the micron of Lake Florissant. A valuable investiga-

ıre 2 (above). SEM of ther diatom type.

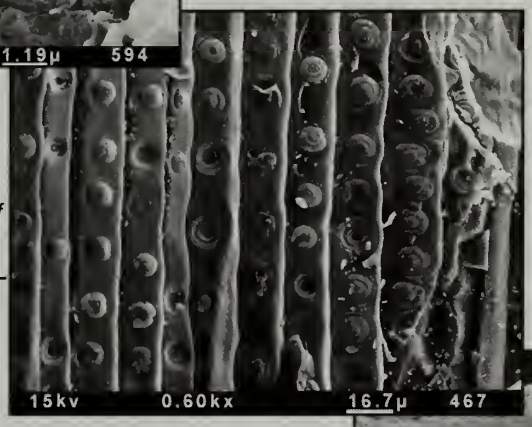


Figure 3 (right). SEM of redwood tree structures.

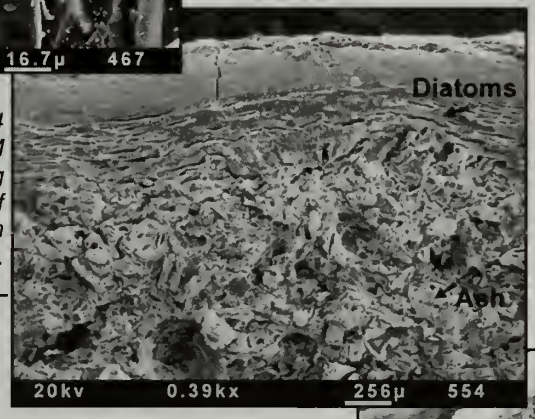


Figure 4 (right). SEM showing layers of volcanic ash and diatoms.

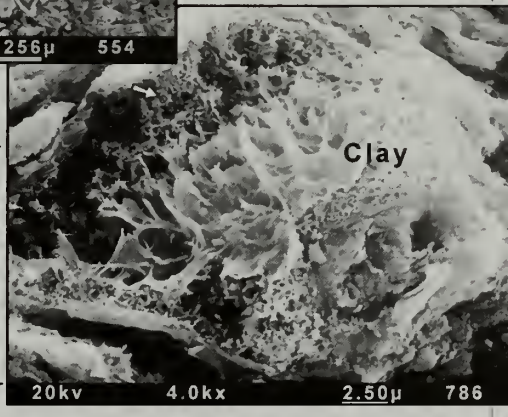


Figure 5 (right). SEM showing weathering of ash (arrow) to smectite clay. Notice how the clay appears to grow like a thin film on the solid volcanic grain.

Another aspect of our study is to learn about the chemical changes that take place in volcanic sediments during and after deposition. Geologists commonly know that volcanic ash weathers to a clay mineral called smectite. The shapes of the ash particles are indicators of the weathering processes. Our results have shown details (fig. 5) of the process of a volcanic grain (see the arrow) changing to clay (C in fig. 5). Our future investigations will attempt to determine morphological differences between airborne and washed-in grains in order to understand the geologic events responsible for filling in the lake.

tory procedure that supplements the scanning electron microscope and aids in identification of the chemical composition of particles is energy dispersive X-ray analysis (EDX), which gives an elemental analysis of the substance in the SEM viewing area. The EDX pattern of the spore picture confirms a carbon (thus organic) composition of the particles. EDX has been useful in recognizing the composition of other fossils and sediment particles. The minute details of a petrified redwood tree are visible in the SEM view in figure 3.

The lake deposits frequently show an alternation of volcanic ash and diatom layers (fig. 4). The famous insects, leaves, and other fossil remains commonly occur entombed in the fine ash. Apparently, their delicate remains were not disturbed as they were buried in the fine volcanic ash, which was washed into the lake basin from land or fell from ash clouds over the lake itself. Figure 4 shows layers of ash and diatoms. As our study continues, we wish to determine the period of time represented by an ash-diatom couplet (or pair). In some lake deposits, couplets represent 1 year of deposition. Determining the time represented by the couplets in the Florissant deposits would help determine the duration of the lake's existence.

Further Studies

To date, our observations reveal an abundance of small-scale fossils and mineralogical evidence in the ancient lake deposits. Much of this evidence has not been previously obtained simply because no one used the scanning electron microscope to journey into the microscopic world. Also, the other remarkably preserved and larger fossils have absorbed the attention of most investigators. We hope to continue gathering more evidence of features at the microscopic level because it promises to reveal further clues about lake history. Currently underway is a detailed study to determine the geological features present in sediments deposited near the ancient lake shore and along a traverse out into the center of the lake itself. Results should provide clues of the constancy of or amount of change in sedimentary lake processes and thus help in reconstructing ancient lake history. Results of this study including the SEM photos also are to be arranged in an interpretive display for the visitor center. Our contribution shows that there is another facet of the Florissant fossil beds, which is revealed in the intriguing "world of the micron."

Literature Cited

McLeroy, C.A., and R.Y. Anderson. 1966. Lamination of the Oligocene Florissant Lake deposits, Colorado. Geological Society of America Bulletin 77:605-618.

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Engineering marvel of the 1930s, Hoover Dam and its Lake Mead National Recreation Area home were the site of a November meeting to assess the effects of the NPS reengineering and restructuring phenomenon of the 1990s on natural resource management and science.

Is the Natural Resource Discipline Flourishing?

A summary of the Lake Mead meeting on natural resource management in the restructured NPS

By the editor

GOVERNMENT REINVENTION, one theme of our work over the last year and a half, has brought about fundamental and long-lasting change to everyone associated with natural resource management and science in the National Park Service. Some changes are positive for resource management while others are still evolving. However, where initial success in the transition has been high, more recent indications are that it has slowed or, in some cases, stalled altogether. Some problems associated with the complex task of bringing about fundamental cultural change are just beginning to surface and be studied and understood. Mid-course correction is now needed to address staffing, communication, and funding problems in order to enable natural resource managers to work effectively and flourish under the new structure.

The current state of resource management was the subject of a November meeting of a broad range of resource management professionals who gathered at Lake Mead National Recreation Area (see photo), Nevada. Associate Director for Natural Resource Stewardship and Science Mike Soukup set the tone for the 2½-day meeting by acknowledging that the reorganization has had a profound effect on everyone in the National Park Service. The associate director charged the nearly 45 resource management professionals from parks, system support offices (SSOs), the National Natural Resource Program Center (NNRPC), and field directorates with the task of assessing the effects of restructuring on resource management and moving beyond problems by focusing on the areas that are most important to further natural resource management in the parks.

Changes in Communication

Over the next 2½ days, the group heard 25 sessions that covered the spectrum of natural resource activities taking place in parks, SSOs, at the field area level, in the NNRPC, and within the Washington Office. From the start, meeting participants indicated that communication had increased out of necessity, but had become more complex under the new organization. They also noted that cooperation between parks and SSOs is up. Creativity is high and field areas, most SSOs, and most clusters (groups of biologically, geographically, or culturally associated parks) are devising individual approaches to managing day-to-day concerns. Thus, functions that were once familiar across regions may not exist any longer or may have changed substantially making communication both vital and a basic challenge for nearly everyone.

Adding to communication complexities are the differences by which SSOs have filled out their new structures. Two field areas (the Pacific/West and Intermountain) have largely completed their organizations, filled positions, and generally understand how they will function. The Pacific West Field Area has nine positions in three SSOs related to natural resource management excluding GIS and compliance; the Columbia Cascades SSO has an additional 3.3 positions for GIS and compliance. The Intermountain Field Area reports 18 positions filled, including six devoted to GIS and one for compliance. At the other extreme are the Southeast and National Capital Field Areas, for they have little or no staff in their SSOs to provide park support. The other field areas are somewhere in between. For example, the Northeast Field Area has 15 positions allocated for three SSOs, including the compliance and GIS functions, but only eight are filled and two of the seven vacancies are unfunded. Likewise, only half of the Midwest Field Area's 13 required positions (including GIS, but excluding compliance) for two SSOs are funded and filled. An additional two positions are needed for compliance.

Many resource management job titles are new, longer than before, and reflect new roles and functions for many positions. For example, each field area now has an Associate Field Director for Natural Resource Stewardship and Science (or similar title) that was filled, in most cases, by a former regional chief scientist. The role has changed from one of coordinating the science and resource management activities for a region (with line authority, programs, and budgets) to one of filling a strictly advisory role with no funds, staff, or programs. While these positions may also include other areas of responsibility, such as planning, the incumbents raise important resource management concerns to the field directors and still serve a liaison function between the field, CPSUs (cooperative park studies units), and the National Biological Service. As an exception, two former chief scientists have retained the title of Chief Scientist and now serve the Allegheny/Chesapeake and New England SSOs in advisory and coordination roles.

At the system support office level, one former regional chief scientist and several regional chiefs of resource management have become either Team Coordinators for Stewardship and Partnerships (supervisory positions with a broader role than the former regional chief of resource management) or Program Leaders for Natural Resources who report to the team coordinator. Program leaders work with small staffs of SSO resource managers, but are no longer supervisors.

Alaska Different

Whereas all field areas are trying different operational approaches under restructuring, the Alaska Field Area has changed very little. The legal requirements for subsistence fishing and hunting, etc., under ANILCA (the 1980 legislation creating most Alaskan parks in their present form), combined with severe park isolation and lack of park housing led to a practical and successful central office organizational approach. The Alaska SSO has requested that the National Leadership Council allow them to maintain higher central personnel levels than originally targeted for downsizing. If granted, the positions would have to come from unfilled positions elsewhere.

The Alaska Cluster of parks, like the National Capital Cluster, also has adopted no new structure. With just 14 superintendents, this group already functioned somewhat like a cluster and has not had to make fundamental changes.

Cluster Considerations

The focus on the cluster is perhaps the biggest change affecting parks in the reorganization. Where parks formerly constituted the basic unit of planning and work, clusters are now beginning to play this role. In the case of the Pacific/Great Basin Cluster, annual cluster work planning is becoming as important as park work planning has been. Larry Bancroft, Sequoia-Kings Canyon National Park Chief of Resource Management explained, "[Restructuring] has removed the prioritization processes that [we] normally went through with strategic planning and leads [us] to try to take on everything at high quality. We can't. We must prioritize, then we could come out ahead... Now the clusters must approach work plans cluster by cluster. Then [we] must share the resources to get the work done." Carrying this new concept through to a practical conclusion, Air Resources Division Chief John Christiano noted that "park hiring may need to be influenced by the greater needs of the cluster rather than the individual needs of the park. A cluster may need to do a staffing plan for the good of the cluster."

While locating the right person for a particular purpose has become more difficult as staff learn how the clusters and system support offices function, communication between superintendents has increased. Superintendents now have more decision making power and budgetary control than in the past and are competing less with one another for funds. Instead, they tend to be considering the broad range of issues for all parks in their respective clusters. They now have no regional office funds to compete for, but must decide how to divide monies amongst themselves.

To help provide leadership for the cluster, many clusters have adopted a "cluster executive council," a subgroup of cluster superintendents, to take action on cluster concerns and communicate with the field director on behalf of the cluster. Here, too, different approaches to the same circumstance have evolved. Some clusters have identified one superintendent as an "executive superintendent," while others use the council format, but call this group by another name. One field area cluster uses a "desk officer" to act as liaison with the field director, another uses an "advocate." The Alaska and National Capital Clusters have no such group at all. Whatever it is called, this function is important to natural resource management as it often serves to prioritize projects for the cluster, feeding projects into the list of priorities for the field area at large.

Superintendents Key

Under the new order, superintendents have clearly become more important for the advancement of resource management. Less emphasis on resource management is coming from central offices and superintendents are the ones who must become advocates for resource management as a management tool. This puts added emphasis on the need for resource management experience or training for

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superintendents, especially first time superintendents and those with assignments in small parks.

Southeast Field Area Associate Field Director for Natural Resource Stewardship and Science Suzette Kimball has noticed both positive and negative effects of this role elevation. "Park superintendents," she commented, "have become involved in the [resource management] issues, have had to set priorities, and have become more technically proficient in the skills necessary to evaluate resource management problems [than in the past. However,] much is not getting done at all or as well as it once was being done." Nevertheless, resource managers in general have been able to increase contact with their superintendents since restructuring. With support no longer coming from the regional office level, superintendents must rely on help from park resource management staff more.

To help them deal with natural resource concerns, some clusters are using natural resource advisory groups (often chiefs of resource management), subordinate to the cluster leadership, to bring forth recommendations, identify priorities, carry out the staff work associated with natural resources, and give advice on natural resource issues. For example, the Columbia/Cascades Cluster has identified a natural and cultural resource advisory group and the Pacific and Great Basin Clusters share such an advisory group. The Pacific West Field Area also has an advisory committee for natural resources at the field area level. Areas of member expertise may include natural resource program management, the National Biological Service, or other technical areas. Some clusters, however, have no such organ and either rely on the cluster executive council to fill this niche or convene ad hoc groups at their discretion (with some eventually becoming permanent structures).

With scarce resources all around, Ocmulgee National Monument Superintendent John Bundy indicated that resource management projects must be promoted on the basis of how they add value, lead to lower cost or simplification, or could compete on the open market. "It's crisis management in the field," he added, "and long-term resource management needs are hard to sell." He also said that the more ties a resource management proposal has to legal mandates, the more leverage it has. Public education is also necessary to gain support for long-term resource management funding.

Under the new order, superintendents have become more important for the advancement of resource management

SSOs and Technical Support

Under the new structure, SSOs have replaced regional offices for field support, but they have no line authority or budgetary control as in the past. Through downsizing, they have generally lost personnel to the field in numbers that they no longer have the complete complement of expertise that they had under the regional office system. Instead, expertise must be shared among parks and their respective SSOs; SSOs now have to delegate some work to parks to serve the cluster effectively.

Some superintendents are surprised at the amount of work this is generating. Not surprisingly, larger parks with better developed resource management programs are beginning to feel the burden of these requests. Smaller parks are beginning to look to them for help, and unfortunately, the phones in *some* SSOs are no longer ringing. Although interpark work experiences offer terrific professionalization opportunities, superintendents are sure to have a tough time responding to all requests without staff and budget increases.

SSOs have lost personnel in numbers that they must now partn with parks to serve clusters effective

A potential solution is to share SSO expertise across cluster boundaries as the SSOs of the Intermountain Field Area have done. Janet Wise, Natural Resource Program Leader for the Colorado Plateau SSO indicated that 60% of their SSO positions operate across cluster boundaries, increasing the expertise each SSO has to offer parks. Where SSO expertise is lacking, they have identified park expert leads or cooperating students pursuing higher degrees to fill the niches. They also use one Denver Service Center natural resource planner living in a park for support. Their creative approach has given more resources to parks without having to fill the positions from within. In the spirit of reengineering, they served an important coordination role assembling a complete set of experts from a variety of sources.

Unfortunately, this is not yet an option for SSOs that are very poorly staffed. As already mentioned, the Atlantic Coast and Gulf Coast SSOs have no permanent staff person to call for support, and the Appalachian SSO has only one–the Natural Resource Program Leader. After directing their attention toward reducing central office staff, the Southeast Field Area was prepared to rehire for restructured positions when a hiring freeze went into effect. In order to accomplish some resource management work while their positions have remained empty, they have made good use of contractors and cooperative agreements. However, they expect to begin losing ground if they cannot fill approved vacant positions. Likewise, the National Capital SSO has no staff related to natural resource management. These numbers are unusually low for SSOs (most others have 3-6 filled positions, including clerical) and reflect the most current and potentially difficult problem for resource management in the National Park Service: lack of funds to fill approved positions.

Filling Professional Positions

The money problem is not the result of restructuring per se; restructuring may have been predicated on a faulty assumption of increasing staff *and* funds at the

park level, while reducing the same in central offices. Although central office staff reductions are generally progressing at a pace to meet 1999 personnel targets, the funds to pay for the increased staff in parks this fiscal year are lacking. As Northeast Field Area Associate Director for Natural Resource Stewardship and Planning Bob McIntosh summarized, "The budget is the key for parks to be able to pick up the responsibilities being dropped by the central offices... We must get growth back into the parks or they will begin to lose ground."

Tighter funds also means that central offices may not have until 1999 to meet their reduced personnel targets. The implication for parks, if reductions in force (RIFs) are to be avoided, is that they may be asked to take experienced, yet professionally unqualified, staff into resource management positions. Furthermore, the Department of the Interior (DOI) has begun to require that displaced DOI employees be considered for vacancies rather than allowing parks to recruit. This situation could have long-term ramifications for the professionalization of natural resource management and makes each hire, however restricted, especially important.

Restructuring may have been predicated on a faulty premise that central office staff and funding reductions would be offset by growth in park

National Programs

Associate Director Soukup outlined the new national natural resource organization, indicating that restructuring has had a very positive effect on the former Washington Office programs. Now organized under a National Natural Resource Program Center, located primarily in Colorado, six programs formerly operating under three different associate directors have been consolidated and strengthened through their closer association with one another. The NNRPC is now comprised of the Air Resources Division (formerly Air Quality), Water Resources Division, Geologic Resources Division (formerly Mining and Minerals), Environmental Quality Division, Natural Systems Office, and the Natural Resource Management Information Division.

Both the Geologic Resources Division and the Environmental Quality Division are new to the Natural Resource Stewardship and Science Directorate, but already have well developed programs that serve parks very effectively. The Geologic Resources Division has recently hired a cave specialist and is trying to expand its mission beyond mining and minerals to include other geologic resources. The Environmental Quality Division improves the national natural resource connection with park operations. This group brings scientific data to the compliance process and facilitates the use of compliance planning tools (e.g., NEPA) in parks. They also conduct damage assessment procedures following environmental disasters (like the Exxon Valdez).

The new divisions (Natural Resource Information Division and Natural Systems Management Office) are comprised of some staff that formerly worked for the Wildlife and Vegetation Division (now dissolved). The former will assist parks in making better use of existing databases and will develop systems for facilitating a free exchange of natural resource information over the next several years. The Inventory and Monitoring Program, resource management database, national GIS coordination, and publications functions (including *Park Science*) now reside here. The Natural Systems Office will devote its time to helping parks deal with boundary influences, and will support parks negotiating land use easements with park neighbors. They may also help national park areas begin to approach strategic planning on a landscape scale. Some familiar programs once in the Wildlife and Vegetation Division are now here, such as National Natural Landmarks, Man and the Biosphere, Threatened and Endangered Species, and Exotic Species Management. A new direction for this group is furthering partnerships through grant writing and developing cooperative agreements. These efforts have already paid off with a $1.2 million grant from Canon that was dedicated to park natural resource management projects.

Soukup explained that his emphasis in Washington will be on advocacy for the national natural resource program, and he discussed several initiatives afoot to improve our capabilities. He has brought Dr. Gary Machlis of the University of Idaho on board at the national level for 2½ years to establish a basic social science program in the National Park Service. Most likely, this will be a CPSU (cooperative park studies unit) based program that will need to raise much of its own funding, but it will provide an important service for parks. Soukup has also applied for a Pugh Foundation grant to fund a visiting Chief Natural Scientist position. If filled, this person will help focus the National Park Service on the need for science in park management. Soukup will continue to look for other funding sources to accomplish more research and resource management work in parks.

With the reorganization of the former Washington Office functions, parks now have greater technical expertise available in one place. The NNRPC will be publicizing the scope of services available to parks before contacting parks to offer technical assistance. Furthermore, they plan to unify all calls for assistance, incorporating those for both NRPP research (NBS provided) and resource management projects, to simplify the process.

Research

Cooperative Park Studies Units remain central to accomplishing research in national parks, and Mike Soukup encouraged natural resource professionals to strengthen ties with these valuable partners. The resources that CPSUs make available to parks are so useful that Soukup suggested that we broaden the cooperative agreements and go beyond research to include other programs, such as interpretation, cultural resources, and training. The status of some CPSUs was not clear since establishment of the National Biological Service and other changes in agreements, and the group agreed to update a list of CPSUs for the entire national park system.

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Restructuring continued

Participants also discussed the services provided by the National Biological Service, another primary NPS research source. A little over 2 years ago, we transferred $30 million and 173 positions to the fledgling research agency. This change has required greater effort in parks to get assistance, and the problem appears to have become worse recently with the specter of NBS dissolution and eventual transfer to the U.S. Geological Survey. Now it is harder to get the same level of service as we got initially, and potential cuts to previous NPS projects worry many. Several meeting participants voiced their concerns about the fate of NRPP research projects given to the National Biological Service to carry out, when they may not have the expertise to do so. Others voiced frustration with having produced project priority lists without having seen results. The group resolved to support the NBS during this time of transition, but to get them to share their fiscal year 1996 work plan with us to help us track their level of support. Meanwhile, the associate director will be working on long-term solutions to concerns about the erosion of funding and other difficulties in working with these partners.

Clearly, science and resource management are partners, and where one experiences setbacks, the other feels the impacts. The link between research and resource management needs to be strengthened for resource management to be its best in parks.

Ad Hoc Report

The 1995 Report of the Ad Hoc Working Group on Natural Resource Management in the National Park Service has always been our benchmark against which to measure the effects of restructuring on the natural resource management discipline. At the close of the meeting, participants agreed that many items identified in the document still needed to be implemented to complete restructuring and realize further benefits for resource management. They included: keeping the Natural Resource Stewardship Today for Parks Tomorrow initiative going in the hopes of eventually increasing resource management positions in parks; participating fully in the new NPS training strategy to make sure natural resource needs are fully met (including supporting a resource management fundamentals course this year); continuing to encourage superintendents to build resource management expertise in the parks and to include resource managers in the decision making process; completing the fiscal year 1996 goals of the Vail Agenda natural resource careers committee; promoting GIS as a general park management tool; and improving the service of the National Biological Service through participation in their strategic planning meetings.

Summary

Restructuring has created a very different National Park Service in relation to natural resource management and science. Science must be specific and relevant to park management problems and must have a broader role in support of law enforcement and interpretation in addition to resource management. Resource managers now have greater access to superintendents these days, giving them improved opportunities to contribute their concerns and data to the decision making process. Creativity in problem solving is high, and more coordination and cooperation is taking place between parks and central offices. Professional development opportunities for resource managers seem nearly limitless. Yet, the times have also created serious problems that appear to be setbacks for resource management.

Professionalization and technical support are areas where we appear to be having the greatest trouble. Budgets and position target limits have reduced the technical expertise in the system support offices and have not allowed parks to make up the difference as originally expected. Hiring restrictions may prevent parks from attracting the professionals that are needed, and SSOs are in jeopardy of failing in regard to resource management technical support. Garnering support for long-term resource management projects is also especially difficult now with fiscal resources so scarce. Solutions to these problems appear to be limited to finding other funds (through government budget initiatives, soft monies, partnerships) to help us make progress. A separate initiative to create new research grade technical support scientist positions in parks (conducting applied science) is also needed, and this potential solution may be explored this year.

The empowerment of superintendents in the restructured National Park Service may have the greatest effect on resource management in the long run. Where Assistant Secretary Frampton initially vowed that restructuring would create an environment where resource management could "flourish," we now have an organization that will allow this to happen, but only if additional funds are found and superintendents promote and use the science and resource management tool. Consequently, the consensus of the group is that superintendents need to be oriented to the resource management profession. We also need to encourage resource managers to develop the skills necessary for becoming effective superintendents.

Through a grant, Soukup hopes to fill a visiting Chief Natural Scientist position to strengthen NPS focus on science in park management

With all that has changed, we may take pleasure in knowing that some of the things that we have always done well, we can and should continue to do as before. The RMAP database giving us objectivity in making our case for growth in the resource management profession, the resource management database giving superintendents and the NNRPC a tool for providing assistance, the NRPP funding for resource management projects, and our ability to prioritize park needs all put us in a position to get attention and support when times begin to favor resource management again.

PARK SCIENCE INDEX—1995

ALPHABETICAL BY AUTHOR, PARK, AND KEYWORD

Editor's Note: *Entries pertain to volume 15 (1995) numbers 1-4 (winter, spring, summer, fall, respectively). Issue number is shown in parentheses, followed by page numbers where the article containing the referenced entry can be found.*

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1995 Park Science Feature Articles in Summary

BY GENERAL SUBJECT

Resource Restoration

- Several agencies cooperated in an ambitious project to reconstruct the long-disturbed, Washington, D.C. Kenilworth Marsh **(1)**:1,16-18.
- Planning that included site suitability assessments and hydrologic and vegetation monitoring will be key to wetland restoration in Indiana Dunes National Lakeshore **(1)**:23.
- Biologists introduced captive-bred ferrets in Badlands National Park as part of the National Black-footed Ferret Recovery Plan **(2)**:1,16-18.
- Larvae of the threatened northeastern beach tiger beetle were translocated from the Chesapeake Bay to the Sandy Hook unit of Gateway National Recreation Area **(3)**:1,16-17 (see illustration, far right).
- An experiment compared three potential methods for restoring native vegetation to razed residential sites within Indiana Dunes National Lakeshore and their costs **(4)**:18-20.
- Managers and biologists prepared for summer and winter releases of black bears within Big South Fork National River and Recreation Area **(4)**:24-26.
- Following a wildfire, Santa Monica Mountains National Recreation Area and its neighbors came together to revegetate part of a 32-acre site using native plants **(4)**:28-30.

Population Ecology

- A multiyear landscape ecology study of nesting loons at Isle Royale National Park began to answer some basic population ecology questions of the wilderness bird **(1)**:20-21.
- Satellite radiotelemetry used with falcons and eagles from Alaska and Arizona-Utah parks revealed astonishing details about their sometimes intercontinental migrations **(2)**:20-24.
- Tagging studies suggested that Hawksbill turtles migrate long distances between their Buck Island Reef National Monument nesting grounds and wintering areas elsewhere in the Caribbean **(2)**:25.

General Wildlife

- Wolves are rapidly returning to the Michigan Upper Peninsula and Pictured Rocks National Lakeshore where park staff are assisting regional educators and other managers in tracking the recovery **(4)**:15, 27.
- Park managers and interpreters gained useful information on the behavioral ecology of the striped skunk at Great Smoky Mountains National Park **(4)**:22-23 (top photo).
- Resource managers at Yosemite, Sequoia, and Kings Canyon National Parks reported reductions in bear-human conflicts over the last 15 years **(4)**:31.

Inventories

- Pecos National Monument mammal surveys provided the data needed to link the 1993 hantavirus epidemic with a rodent population explosion in the Southwest **(2)**:12-13.
- Spruce grouse at Acadia National Park were studied and may be making a comeback, but fragmented habitat on Mount Desert Island will complicate managing for species success **(3)**:10-11 (middle photo).

Geologic Resources

- Polyurethane foam proved to be a portable, affordable, and easily managed material for low-impact sealing of remote and potentially dangerous abandoned mines **(1)**:14-15,28.
- Visitor impacts ranging from inadvertent trail widening to illegal collecting of pocketsized volcanic bombs lead resource managers at Craters of the Moon National Monument to initiate a photography-based geologic features monitoring program **(1)**:22.
- Geologists and atmospheric scientists measured the ratio of cosmogenic to atmospheric hydrogen in surface basalts at Capulin Volcano National Monument suggesting that the mountain is much older than previously thought **(2)**:10-11.
- After 60 years of incorrect interpretation, paleontologists set the record straight on a late Triassic dinosaur track at Gettysburg National Military Park **(2)**:9.

Water Resources

- The U.S. Geological Survey NAWQUA program provided a likely means for Morristown National Historical Park to establish a park water quality sampling site for monitoring long-term water quality trends **(1)**:28.
- A review of federal wetlands regulations indicated that while they can slow park construction projects, they also minimize park facilities impacts and provide protection from external threats **(2)**:14-15.

Marine Resources

- Unpaved road erosion and subsequent marine resource sedimentation in Virgin Islands National Park are shown to be linked, indicating the need for immediate corrective action **(2)**:26-28.

Partnerships

- The NBS science centers are a potential source for park technical assistance, but networking is a key to tapping this resource **(2)**:29-31. The NBS Midcontinent Ecological Science Center focuses on ecological research and technologies development to improve biological systems understanding and management in the western interior United States **(3)**:12-14.
- Twenty parks with resource management inventory and monitoring project needs received a total of $1,200,000 from the Canon Corporation to get the work accomplished **(4)**:12.
- The National Biological Service requested widespread input in documenting the history of land use in North America, potentially resulting in a tool that would allow land managers to project likely outcomes of future land perturbations based on historical ones **(4)**:21.
- Students from the Buffalo National River watershed learned water quality analysis techniques and spoke out on the value of the regional resource **(3)**:15,17.

General Resource Management

- A resource manager gained inspiration from a series of natural events (a wildfire and both a bald eagle nest and a rare lily population discovery) that occurred in close proximity with one another over 4 months in Isle Royale National Park **(1)**:13.

Resource Mgmt. Administration

- The Assistant Secretary of the Interior convened an ad hoc task force to recommend measures to advance the natural resource discipline under NPS restructuring **(2)**:8,15.
- Grand Canyon National Park reorganized its science and resource management functions in a new science center that accentuated partnerships **(3)**:23.
- Colorado Plateau parks considered NPS restructuring and the resulting clusters of ecologically similar parks advantageous in addressing water resource issues related to Glen Canyon Dam **(4)**:14,27.

Fire Management

- A landscape-scale fire history study of the Jemez Mountains near Bandelier National Monument revealed frequent fires until the 1890s and suggested the need to allow fire management programs to proceed with prescribed burns today **(3)**:18-19.
- Glacier National Park carefully used its updated fire management plan to allow several prescribed natural fires to run their courses **(3)**:18-19.

Data Management

- Yellowstone National Park unveiled a computerized rare animal reporting system that facilitates data analysis and retrieval **(2)**:3.
- A natural resource bibliography of Pacific Northwest park-held references was the first of its kind and served as a model for other subsequently developed park and regional bibliographies **(2)**:19.

GIS

- An ambitious project to develop a regional GIS database will allow national parks to develop interagency partnerships for ecosystem management based on scientific principles **(3)**:24-26.

Social Sciences

- Sociologists described the visitor-employed photography technique of assessing visitor values, applied at Rocky Mountain National Park **(1)**:10-12.

Archeology

- Archeologists documenting cultural resources at a Yellowstone National Park grizzly bear habitat rehabilitation site teamed with geologists to reconstruct dates of prehistoric human activity **(3)**:28-31.
- When examined under a scanning electron microscope, pictographs at Amistad National Recreation Area revealed an unusual mineral accretion of a biological origin that both protects and obscures the rock art **(4)**:1,16-17 (bottom photo).

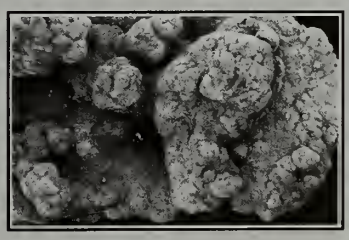
Memorials

- Reminding us that field research has risks, a NBS field station leader reported the deaths of Florida cougar researchers Craig Johnson and Scott Shull when their airplane crashed in Big Cypress National Preserve during an aerial survey **(1)**:24.
- Alpine botanist and oldest and longest serving park ranger Carl Sharsmith died at 91 **(1)**:25.

Publications

- Park Ranger Rick McIntyre's *A Society of Wolves* was reviewed as a well-researched, engaging personal account on the biology of the wolf **(1)**:26-27.
- *Saving Nature's Legacy* was characterized as a readable synthesis of the important aspects of the broad discipline of conservation biology **(3)**:27.
- *These American Lands* was cast as both a major resource in and an advocacy organization's (the Wilderness Society) interpretation of the history of federal land management **(4)**:11.
- The Natural Resources Publication Office announced the availability of six new publications **(1)**:27.

PS



Meetings of Interest

MAY 1-3

The First Conference on Resource Management and Research in Southern Arizona National Park Areas will take place at the Hilton East Hotel in Tucson. Conference sessions and posters will address major fields of research and resource management, including archeology, historical preservation, plant ecology and management, wildlife ecology and management, multidisciplinary-ecosystem issues, and physical sciences. The preregistration deadline is March 1. For more information, contact Tim Tibbitts, (520) 387-7661, ext. 7114.

MAY 7-10

The 20th Tall Timbers Fire Ecology Conference will get under way next spring in Boise, Idaho. Entitled, "Fire in Ecosystem Management: Shifting the Paradigm from Suppression to Prescription," the conference aims to discuss specific prescribed fire regime alternatives in the context of modern natural resource management and policy. Many sessions will adopt a case study approach and will link the use of prescribed fire with long-term management objectives to achieve specific future forest, shrub, or grassland ecosystem conditions. Contact Leonard Brennan, Director of Research, Tall Timbers Research Station, Route 1, Box 678, Tallahassee, Florida 32312-9712; (904) 893-4153, ext. 222; fax (904) 668-7781; e-mail "brennan@bio.fsu.edu" for more information.

MAY 18-23

Pennsylvania State University will host the 6th Symposium on Society and Resource Management, focusing on the usefulness of the social sciences to natural resource decision makers and managers. Attendees will have the opportunity to participate in a wide range of professional development and educational programs including concurrent paper, thematic, and dialogue sessions; a poster session; plenary addresses; field trips; and receptions. Contact Jim Finley, Program Co-chair, School of Forest Resources, The Pennsylvania State University, 2B Ferguson Building, University Park, PA 16802, fax (814) 865-3725, e-mail "FJ4@psuvm.psu.edu" for further information.

JUNE 9-14

The Society of Wetland Scientists will hold their 17th annual meeting, entitled "From Small Streams to Big Rivers," in the central business district of Kansas City, Missouri. Technical sessions, field trips, and workshops will include wetlands biodiversity, hydrology, soil and geomorphology, classification and evaluation, long-term monitoring, ethnobotany, and stream bioengineering, among many others. Further details appeared in the December issue of the *SWS Bulletin* with another follow-up due in March.

1997
SEPTEMBER 18-20

The Third Biennial Rocky Mountain Anthropological Conference will be held in Bozeman, Montana and will feature forums as an alternative to symposia, to enable thoughtful, focused, and more open discussion of carefully delineated topics. The deadline for symposia and forum proposals is March 15, 1997. Other deadlines and information will be announced in future communications. Contact Ken Cannon, National Park Service, Midwest Archeological Center, Federal Bldg., Room 474, 100 Centennial Mall North, Lincoln, NE 68508-3873, (402) 437-5392, ext. 139, fax (402) 437-5098, e-mail "ken_cannon@nps.gov" or Jack Fisher, Department of Sociology, Montana State University, Bozeman, MT 59717, (406) 994-5250, fax (406) 994-6879, e-mail "isijf@msu.oscs.montana.edu", to discuss proposals.

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Integrating Resource and Visitor Management
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PARK SCIENCE
Integrating Research and Resource Management

Volume 16—Number 2 National Park Service • U.S. Department of the Interior Spring 1996

Negotiated Rule Making as a Resource and Visitor Management Tool

A case study in the use of FACA

By Linda Canzanelli and Michael Reynolds

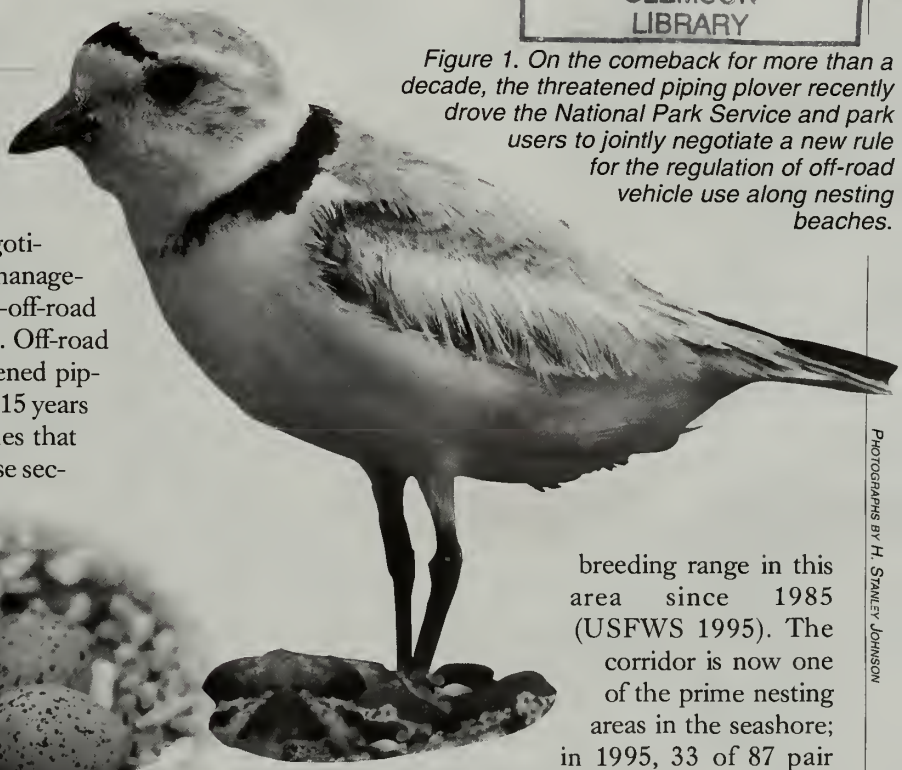

Figure 1. On the comeback for more than a decade, the threatened piping plover recently drove the National Park Service and park users to jointly negotiate a new rule for the regulation of off-road vehicle use along nesting beaches.

Photographs by H. Stanley Johnson

CAPE COD NATIONAL SEASHORE, Massachusetts, recently tried *negotiated rule making* (per FACA, the Federal Advisory Commission Act, P.L. 92-463, 5 U.S.C. App. II Sec. 9(c), and the Negotiated Rulemaking Act, 5 U.S.C. Sec 561-570) as a management tool to resolve an ongoing contentious issue–off-road vehicle (ORV) use on the national seashore beaches. Off-road vehicle use and management of the federally threatened piping plover *(Charadrius melodus* [fig. 1]) has led to over 15 years of controversy, litigation, and different proposed rules that not only attempted to allow ORV access, but also close sections of beach for the plover in compliance with the Endangered Species Act.

Background

In 1981, the seashore proposed a new ORV regulation that slightly reduced ORV use. Unsatisfied with the regulation, environmental groups challenged this proposed rule in court. The result was a rewrite of the regulation to what is called the "1985 regulation" (36 CFR 7.67). Environmental groups also challenged this regulation in court, but it was upheld.

The National Park Service would have been content with the 1985 regulation, which established a 13.6-km (8.5-mi) ORV corridor on the 64 km (40 mi) of outer beach within the park (fig. 2, page 16) , except that the piping plover has quadrupled its breeding range in this area since 1985 (USFWS 1995). The corridor is now one of the prime nesting areas in the seashore; in 1995, 33 of 87 pair nested in the corridor (Hoopes 1996). Primarily because of plovers in the corridor, seashore staff monitor every bird, nest, and egg daily to assess if the corridor should be closed or reopened to ORVs. As soon as a nest is identified, symbolic fencing is erected with true exclosures put up once the four eggs are laid; the ORV corridor is closed from the time the birds hatch until they fledge approximately 28 days later. During the past couple of years, on especially busy weekends such as the Fourth of July, we have only been able to open 0.6-1.0 km (0.4-0.6 mi) of the corridor (Hoopes 1996).

Continued on page 16

PARK SCIENCE
Integrating Research and Resource Management
Volume 16—No. 2 • Spring 1996

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

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Roger G. Kennedy

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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations–materials do not undergo refereed peer review. The bulletin is published in January, April, July, and October for distribution to interested parties. Visit *Park Science* on the World Wide Web at *"http://www.aqd.nps.gov/nrid/parksci"*.

Park Science is now accepting donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to the National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Contact the editor for current submission criteria at:

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Printed on recycled paper

CONTENTS

DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

Our look back at the first class of natural resource management trainees in 1984 will finally be featured next issue. Also, bald eagle surveys at Apostle Islands National Lakeshore, Wisconsin; the leave-no-trace camping ethics program; turfgrass research and use in eastern parks; and the successes and pitfalls of maintaining a water quality monitoring program at Sleeping Bear Dunes National Lakeshore, Michigan.

Managing Change

If not for change, we would have nothing to do. As resource managers, we spend most of our time trying to avoid change (of the resources) or bring it about. As scientists, comprehending change, investigating its causes, and determining options for dealing with it is paramount.

This issue features several articles that deal with change. One story examines the dynamic relationship between the NPS and the National Biological Service in the quest for research in support of resource management. The cover story on FACA demonstrates a recent management tool that integrates all park users more thoroughly into park planning.

Economic assessments are not new, but their slow proliferation in park management represents a change in the past decade. As two stories point out, economic assessments may help parks begin to see themselves as some park neighbors do–as sources of economic benefit. More importantly, park neighbors may relate the jobs and income derived from the park to the enduring nature of the resources themselves.

Finally, a pair of articles describes outcomes of the December ecosystem management workshop in Tucson. Managers can expect to see published in the coming year a compendium of scientific ecosystem management case studies that may help them adopt management practices pioneered elsewhere. Managers can also expect an era of change associated with taking this endeavor seriously. In this age, the story on page 15 asserts, human influences on park natural resources are undeniable and *natural process management* alone may no longer be adequate to care for natural resources.

This assessment is timely as the NPS begins to reexamine its natural process management philosophy. Often incorrectly called the "natural regulation" paradigm, the policy states that managers "will try to maintain all the components and processes of naturally evolving park ecosystems…." Its application in wildlife management has been hotly debated for decades, especially in parks where herd sizes of large mammals have been allowed to fluctuate naturally within park boundaries. The NPS will address this philosophy, and the criticism regarding its application, in a series of scholarly, collegial forums to be held in conjunction with several national science conferences over the next 2 years. The first will be Aug. 13 in Rhode Island (see Meetings of Interest on page 32) at the annual conference of the Ecological Society of America.

Many contend that the policy is not flawed, that how it is applied is what needs careful scrutiny. The upcoming review will examine the appropriateness of the policy, given the complexities of natural resource management today, and its application in three case studies: large mammals in Yellowstone, moose and wolves in Isle Royale National Park, and white-tailed deer in eastern U.S. parks. The forums will focus on the current and emerging science and the related human dimensions surrounding these case studies to set the direction of future park management.

Jeff

News & Views

Park Science Now Online

Park Science is now featured on the World Wide Web at *"http://www.aqd.nps.gov/nrid/parksci"*. The home page describes the publication, the issues available online, article submission criteria, and instructions on how to download individual editions in portable document format (PDF) for subsequent viewing and printing. The web site also features an interactive article index that can search for a citation by keyword, park, title, or author, describes how to obtain back issues of the publication, and provides a simple way to get in touch with the editor. Give it a whirl.

Park Science Hard Copies Sought

The editor would like to bind several complete sets of *Park Science* for use as a reference. Needed are two copies of 7(4)–summer 1997. Additional reference sets can be bound if readers would care to donate an entire catalog of issues; most needed are complete sets of volumes 1-12. If you can be of help, please contact the editor (see page 2 for contact information).

Natural Resource Publications Program on Hold

As a result of restructuring, the former Natural Resources Publication Program is on hold indefinitely pending funds to hire a publications coordinator. Authors interested in submitting materials suitable for publication in the familiar Monographs, Natural Resource Report, and Technical Report Series will need to find other avenues for publication. Annual Science Reports, the Proceedings Series, and Highlights in Natural Resource Management have been discontinued; data from previously published Annual Science Reports is still available from the Investigators Annual Report database. A new report, described in the following article, will be initiated this year by the Natural Resource Information Division. *Park Science* will continue to be published.

Parties interested in receiving copies of reports may want to initially contact the authors of the respective reports. Alternatively, the NPS Technical Information Center (TIC) maintains copies of all NPS technical reports and drawings including all natural resource reports. For a fee they will make photocopies or microfiche copies of requested NPS reports for interested readers. Contact them at: Technical Information Center; National Park Service; P.O. Box 25287; (DSC-MS-TIC); Denver CO 80225-0287; through NPS cc:Mail at: "TIC- work orders/requests"; or by e-mail at: *"tic-_work_orders/requests@nps.gov"*.

New Natural Resource Report Needs Your Input

The Natural Resource Information Division of the NPS Natural Resource Program Center has begun preparing a new and comprehensive report aimed at building *outside* support for NPS natural resource preservation goals. Tentatively titled, *Natural Resource Year in Review*, the report will be published in early 1997 and will track the highs and lows of

Continued on page 4

natural resource management in the National Park Service during 1996. An easy-to-read, magazine-format publication, the report will relate stories of immediate interest, informing readers of the status of significant local and national natural resource issues. The report will be based in science, but written for a general audience that includes Congress, the public, and cooperators.

To be truly national in character, the report needs widespread input. Its contents will be developed with an eye toward comprehensive coverage of major and other current events, science and resource management happenings, and national and local issues that have a bearing on the state of the art of resource preservation in the national park system. *Park Science* editor Jeff Selleck is the editor-in-chief for the project and is now soliciting article ideas and editorial assistance.

Article ideas

Readers are invited to submit brief ideas for articles that relate to issues that are significant for both a park and the national park system this year. These synopses may be informal at this stage, but try to capsulize the central issue, problem, or resource management technique and describe how it relates to progress or lost ground in preserving national park system natural resources. Selected article ideas will be developed fully in the fall with the help of an editorial board and park authors. Following are two examples of what the editor is looking for now:

A local issue with broad implications–

Brucellosis, a bovine disease causing fetal abortions in cattle, is carried by Yellowstone bison. For more than a decade, park scientists, local citizens, and state veterinarians have debated the threat of disease transmission from wild, free-ranging bison to nearby cattle. In 1995, after years of controversial bison removals while government agencies tried unsuccessfully to come to agreement on a mutually acceptable bison management plan, Montana sued the National Park Service to try to speed resolution of the issue. The situation brings the lack of consensus concerning the NPS practice of managing for natural processes into question. The bison management debate necessarily requires the National Park Service and its neighbors to face the often conflicting social, economic, and political factors that influence natural resource management issues.

A national issue–

Since 1991, the network of long-term air quality trend monitoring stations has shrunk from 42 to 34 in class 1 airshed parks. Increasing operational costs without accompanying budget increases accounted for these shut downs and also resulted in suspension of baseline monitoring in other parks. These developments make it unlikely for the National Park Service to meet its goal of establishing baseline ozone and SO_2 levels in each of the 48 class 1 airshed parks by the year 2,000. Further reductions in the long-term monitoring network likely will continue as a result of government downsizing.

Forward your ideas to *Park Science* editor Jeff Selleck (see the bottom of the left column on page 2 for contact information) by e-mail, regular mail, or telephone as they come to mind.

Volunteers for advisory board

The editor is also interested in establishing an editorial board for article evaluation and development. If you are interested in serving on an editorial board and would have a few days this fall that you could devote to discussing the merits of the article ideas, prioritizing them, suggesting full treatment outlines for the articles, and possibly writing, please contact the editor. Editorial business will be conducted over e-mail and the telephone, rather than by travel. The editor would like representatives from a broad array of perspectives, including parks (park management, resource management, law enforcement and visitor protection, interpretation, and maintenance divisions), the Natural Resource Program Center, the Office of the Associate Director for Natural Resource Stewardship and Science, and partners.

Deadline

Please submit your preliminary article ideas and indicate your interest in serving on the editorial board by August 30.

In Closing

The *Natural Resource Year in Review* is an exciting prospect. It has the potential of unifying disparate stories from around the country into one message about the NPS role in the welfare of our treasured natural resources. While park visitors and political representatives alike flock to national parks to enjoy their grandeur, they may not understand as well or support as fervently the efforts of natural resource managers and scientists to maintain the health of the parks. The *Natural Resource Year in Review* will address this disconnect. Please give it your support.

Research Grants Available From the Center For Field Research

The Center for Field Research invites proposals for 1997 field grants awarded by its affiliate Earthwatch. Earthwatch is an international, nonprofit organization dedicated to sponsoring research and promoting public education in the sciences and humanities. Grants range from $10,000 to $100,000. Most of the funds contributed to the research projects come from the donations of Earthwatch members, who enlist for the opportunity to join scientists in the field and assist them with their data collection and other research tasks. Thus, nonspecialist volunteers must be integrated into the research design.

In 1996, The Center for Field Research made grants to several projects that had a direct bearing on national park sites: Resource Management Specialist John Roth researched cave formations and macro-invertebrate baselines at Oregon Caves National Monument, Oregon; NBS Research Scientist Judd Howell studied wildlife habitat relationships in Golden Gate National Recreation Area, California; Michigan Technological University Professor Rolf Peterson continued to look at moose-wolf ecology, and specifically the role of wolf predation, at Isle Royale National Park.

Information about Earthwatch field grants is available on the center's World Wide Web site *(http://gaia.earthwatch.org/WWW/gfr.html)* or you can contact: Dr. Andy Hudson, Director, The Center for Field Research, 680 Mt. Auburn Street, Watertown, MA 02172. Telephone (617) 926-8200; fax (617) 926-8532; e-mail *"ahudson@earthwatch.org"* or Sean Doolan, Science Officer, Earthwatch Europe, Belsyre Court, 57 Woodstock Road, Oxford OX2 6HU, United Kingdom. Telephone: (865) 311 600; fax (865) 311 383; e-mail *"ewoxford@vax.oxford.ac.uk"*.

SCIENCE AND ECOSYSTEM MANAGEMENT IN THE NATIONAL PARKS

A Timely Book by William L. Halvorson and Gary E. Davis

By William L. Halvorson

SCIENCE AND ECOSYSTEM Management in the National Parks (ISBN 0-8165-1566-2) underscores that our national parks are more than recreational pleasuring grounds. They are repositories of the nation's biological diversity and contain some of the last ecosystem remnants needed as standards to set reasonable goals for sustainable development on a landscape basis. In the past, public pressure for recreation largely precluded adequate research and resource monitoring in national parks, and ignorance of ecosystem structure and function in parks lead to costly mistakes–such as predator control and fire suppression–that continue to threaten parks. This book demonstrates the value of ecological knowledge in protecting parks and shows how modest investments in knowledge of park ecosystems can pay handsome dividends.

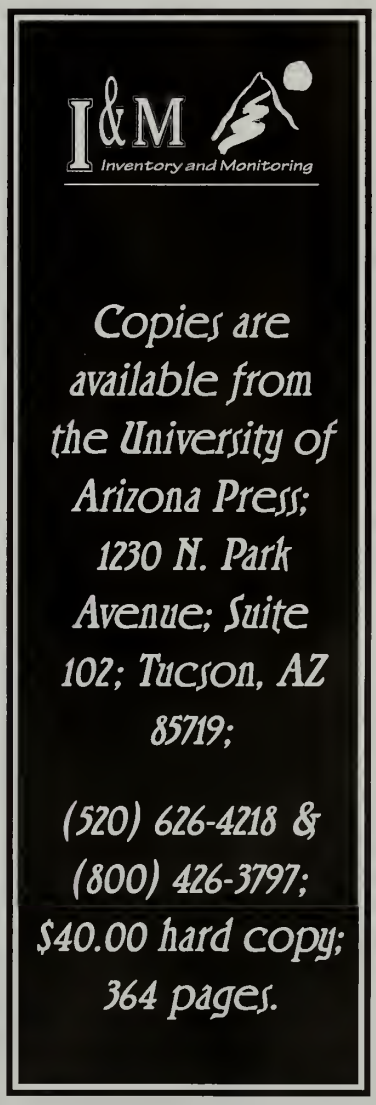
Sponsored by the NPS Inventory and Monitoring (I&M) Program and recently published by the University of Arizona Press, this book presents 12 case studies of long-term research conducted in and around national parks. These case studies were chosen by a panel of NPS scientists and senior managers to address major natural resource issues. The cases show how the use of longer time scales strongly influence a manager's understanding of ecosystems and how interpretations of short-term patterns in nature often change when viewed in the context of long-term data sets. Most importantly, the cases illustrate conclusively that scientific research significantly reduces uncertainty and improves resource management decisions.

The cases offer a broad range of topics, including air quality at Grand Canyon National Park, Arizona, the moose and wolf interaction at Isle Royale National Park, Michigan, alien species at the Hawaiian parks, fire management in the Sierra Nevada (California and Nevada), and the impact of urban expansion on Saguaro National Park, Arizona.

Because national parks are increasingly beset with conflicting views of management, the need for knowledge of park ecosystems becomes even more critical with time–not only for the park units themselves, but for what they can tell us about survival in the rest of the world. This book demonstrates to policy makers and managers that decisions based on knowledge of ecosystems are more enduring and cost effective than decisions derived from uninformed consensus based on belief. It also provides scientists with models for designing research to meet threats to our most precious natural resources.

The I&M Program of the National Park Service was designed in 1992 as a phased program that would eventually include fairly complete resource inventories for some 262 national park system units with significant natural resources. To complete this work over the target 10-year life of the program, the National Park Service planned for annual funding increases that were projected to reach $20,000,000 by 1996 and $26,000,000 in the program's final year. Instead, though most agree with the importance of inventory and monitoring, the program dawdles along at about $6,000,000 annually. The importance of ecosystem level information, demonstrated so well by this book, has not yet been accepted by those that have the responsibility for providing guidance and funds.

The book has been sent to the inventory and monitoring parks, system support offices, field area offices, and the Washington offices of the National Park Service and National Biological Service. It is my hope that this volume will help bring added awareness and impetus to this seriously needed program. PS



William L. Halvorson is Unit Leader of the Cooperative Park Study Unit at the University of Arizona in Tucson. His phone number is (520) 670-6885. Gary Davis is a National Biological Service Marine Biologist at Channel Islands National Park, California; phone (805) 658-5707.

ROCKY MOUNTAIN

Bear Attractant Test of Biodiesel Fuel

In 1994, over 3 million visitors toured Yellowstone National Park, Wyoming. Along with NPS and concessioner vehicles, park visitor vehicles burned over 28.8 million liters (7.6 million gallons) of gasoline and diesel fuel in the park. Pollution from vehicle emissions can have harmful effects on both animal and plant life. In cooperation with the Montana Department of Natural Resources and Conservation and the U.S. Department of Energy, Pacific Northwest and Alaska Regional Bioenergy Program, Yellowstone is participating in a pilot project to evaluate the use of *100% rape ethyl ester* (*biodiesel*) as a low pollution alternative to diesel fuel in environmentally sensitive areas.

Biodiesel emits fewer hydrocarbons and particulates than fossil-based fuels and is derived from renewable resources. It contains negligible levels of sulfur and reduces emissions of sulfur dioxide, one agent responsible for acid rain. Biodiesel is part of the natural cycle (i.e., assimilation of CO_2 by plants for growth and development), and could lead to zero-net-gain in oxides of carbon emissions. The fuel is biodegradable and quickly breaks down, preventing long-term damage to soil or water if spilled.

Yellowstone preserves pristine wildlife habitat and is a premier wildlife viewing park. On occasion, animals, such as grizzly and black bears, may come into close proximity with humans. Biodiesel fuel is a vegetable oil derivative that smells like cooking oil. The exhaust from a biodiesel fueled engine smells similar to a french fry cooker and could attract bears. If bears were attracted to biodiesel powered vehicles, they could be drawn into park developments and roadside corridors resulting in increased bear-human conflicts (human or bear injuries and property damage). This could lead to potential removal of grizzly and black bears from the population. Concerned with this potential, the park conducted tests to determine if raw biodiesel fuel or its emissions were bear attractants.

As part of the tests, bears were exposed to ambient air, odor from raw biodiesel fuel, raw diesel fuel, a deer meat and dog food mix (known attractant), biodiesel exhaust, and diesel exhaust. Of five captive grizzly and five captive black bears tested, none displayed an attraction to ambient air and all displayed a significant attraction to the deer meat and dog food. All bears were indifferent to biodiesel and diesel fuel, but became agitated and aggressive when exposed to the exhaust from these two fuels.

Available at $8 per gallon, biodiesel is not presently a feasible alternative to gasoline and common diesel fuels. Because its use also requires a minor modification to fuel tanks, biodiesel is best suited to individual vehicle fleets, such as those operated by the park and its concessioners. Yellowstone plans to continue field testing the fuel and may be able to increase its use in more park and concessioner vehicles as biodiesel becomes more economical.

For more information on the experiment, contact Mark Biel, Kerry Gunther, or Hopi Hoekstra of the Yellowstone Bear Management Office at (307) 344-2162; e-mail *"k_gunther@nps.gov."*

• • •

More Wolves for Yellowstone

Project biologists released 17 gray wolves in Yellowstone this past winter and early spring as a second phase of the wolf restoration efforts begun there last year. The 11 females and 6 males ranged in age from 9 months to 5 years, weighed between 72 and 130 pounds, and came from 6 packs in British Columbia. In April, following 10 weeks in acclimation pens, the wolves were released and joined 18 wolves already living in and around the park from similar releases in 1995.

The releases came after the late February through early March breeding season in the hopes that the wolves would den in April or May. Acclimated and released in four different areas of the park, two of the four packs scattered. Several wolves wandered to the Gallatin Range northwest of the park. A pregnant female appears to have denned in the Custer National Forest in Montana. Others from her group remained in the park, wandered to the Gallatin National Forest west of the park, and moved to Shoshone National Forest east of the park. A second known pregnant female, carrying six pups, died of hot spring water burns near Old Faithful; her mate remained in the south-central part of the park following her death. Five wolves released near Rose Creek in northern Yellowstone have generally remained in the park in the upper Slough Creek drainage.

Last year's releases of 14 wolves resulted in the birth of nine pups from two packs. Altogether, five wolves have died. A Red Lodge, Montana, man was convicted of killing a male wolf and given a 6 month prison sentence and $10,000 fine. Animal damage control agents dispatched a wolf north of the park after determining that it had preyed on sheep on two separate occasions. The final rule for managing the restored wolves provides for their removal in the event of livestock depredations, and the project biologists and cooperating agencies felt this action would most likely benefit the overall recovery effort. Defenders of Wildlife compensated the ranchers for their livestock losses. Two additional wolves have been shot outside the park in Wyoming. In one case, a rancher turned himself in to authorities when he realized he had mistakenly killed a wolf during a coyote hunt in calving season. Cooperative throughout the investigation, the man was fined $500. The other perpetrator is still at large. The fifth wolf was hit by a vehicle within the park.

Despite these setbacks, the restoration effort is generally thought to be going well. Three of the six original wolves from the Crystal Creek Pack remain generally in the Lamar and Pelican Valleys in the park; winter visitors reported seeing them chase and feed on elk. The Rose Creek Pack stays mostly in the Slough Creek and Hellroaring areas in the park. Last fall, the alpha female and her seven surviving pups were joined by a young male, formerly of the Crystal Creek Pack, who has now become the alpha male.

The Soda Butte Pack ranges along the northern front of the Beartooth Mountains and in upper Slough Creek inside and outside the park. By late April, biologists noted signs that the alpha females from all three of these packs, and possibly some of the newly released packs, were denning.

Especially exciting is news that a male and female from two different 1995 release areas have paired, comprising the first naturally forming wolf pack in Yellowstone in more than 60 years. The pair has mated, appears to have denned, and could have a litter by summer.

Great Plains

Resolving "A (Fish?) Bone of Contention"

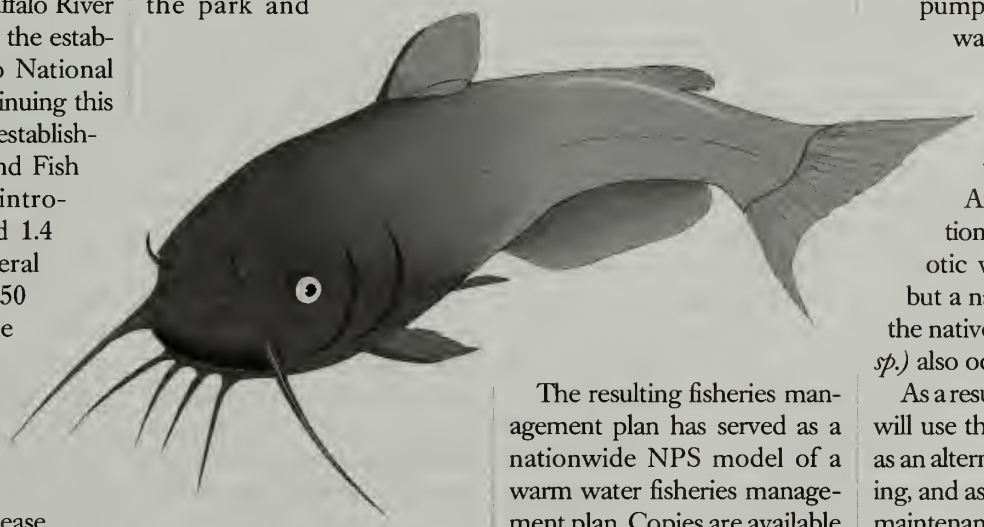
The Arkansas Game and Fish Commission began stocking catfish in the Buffalo River in 1951, long before the establishment of Buffalo National River in 1972. Continuing this practice after park establishment, the Game and Fish Commission has introduced an estimated 1.4 million fish of several species in the past 50 years. In 1988, the stocking issue became contentious when the National Park Service requested the commission to cease stocking catfish in the Buffalo River until adequate scientific data could be collected to assess the effects and results of stocking.

The National Park Service had a serious situation to address. The Game and Fish Commission considered the Buffalo River a *put-and-take fishery* and had a limited concept of NPS fisheries policy. The public was outraged at a misinterpreted newspaper statement attributed to park staff that "catfish probably never existed in the Buffalo River anyway." During this process the park lacked expertise in fisheries management to resolve many of the issues with the state biologists.

How were we to resolve this "bone of contention" as the Game and Fish Commission director described the issue? The park staff attacked the problem on three fronts: holding direct and informal discussions with state biologists, conducting joint fisheries research projects directed at the issue, and developing a cooperative fisheries management plan for the river.

We began by inviting a cadre of NPS, Forest Service, and U.S. Fish and Wildlife Service fisheries biologists to come to the park and develop goals, objectives, and an outline for a fisheries management plan. The resulting draft document was then presented to the state agency field staff for review and discussion before further review by their upper management. This gave us needed support at the field level and resolved many of the basic issues up front. Public meetings were held throughout the watershed for the draft plan review. We also engaged in discussions with the Game and Fish Commission regarding other issues and projects that helped to open dialog and promote better understanding of our mission.

Many benefits accompanied this approach to conflict resolution. Communication between us and the state improved, leading to cooperative projects in other areas of wildlife management. We had access to more complete expertise that the park lacked on its own. Most recently, a Game and Fish employee has been assigned to an interagency liaison post within Buffalo National River headquarters.



The resulting fisheries management plan has served as a nationwide NPS model of a warm water fisheries management plan. Copies are available upon request. Contact the Superintendent, Buffalo National River, National Park Service, P.O. Box 1173, Harrison, AR 72602; 501-741-5443.

Gulf Coast

Salt Spray Alternative to Weeding

In the hot and humid summer months of years past, resource managers at Biscayne National Park, Florida, have labored many hours removing exotic, herbaceous weeds from landscaped areas within the park. The difficult task reduced the exotics, giving the native coastal plants a chance to come back in these areas. Funding constraints and the desire to explore an alternative to commercial herbicides caused resource managers to consider using a salt water treatment of the exotics on a trial basis; native plants are considered to be salt-tolerant, while exotic weeds are not.

The park tested an initial study plot 5 m x 5m (16 ft x 16 ft) in size. Staff applied salt spray to the exotics by attaching a pump to a transportable water tank. Applications thoroughly soaked the area and were repeated within 3 weeks of each other. After just two applications, not only did the exotic vegetation die back, but a natural recruitment of the native salt grass *(Distichlis sp.)* also occurred.

As a result of the test, the park will use the salt spray method as an alternative to costly weeding, and as a way to recruit low maintenance native grasses. Salt grass does not require mowing and is not susceptible to many turf grass pests, such as chinch bugs (reported on in *Park Science* **15**(4):9). Native salt grasses together with natural pest controls are low maintenance, ecologically sound environmental choices.

PS

New Journal Dedicated to Wilderness

The *International Journal of Wilderness*, the only journal to focus on wilderness issues worldwide, published its first edition last fall with contributions from around the world. Articles include new research findings, wilderness strategies, inspirational features, commentary, and reviews. The journal is designed to link professionals, scientists, and the public in a worldwide forum for discussing wilderness research, planning, management, education, and practical experience. John Hendee, Director of the University of Idaho Wilderness Research Center, is the managing editor. The National Park Service is one of 18 leading wilderness management organizations that has sponsored the new publication.

Subscriptions run $30 for individuals and $50 for organizations and libraries per calendar year; Canadian and Mexican subscriptions cost an additional $10. Outside North America add $20. To subscribe, contact the International Journal of Wilderness; the WILD Foundation; 2162 Baldwin Road; Ojai, CA 93023; fax (805) 649-1757; e-mail *"wild@fishnet.net"*. Include your name, address, city, state, zip code, country, and telephone number. For editorial communication, contact the managing editor at *"wrc@uidaho.edu"*.

Wild Horses and Fertility Control

Assateague Island National Seashore, Maryland, may have solved its predicament of what to do about its wild horses. Declared a desirable exotic species in the park enabling legislation, wild horses also damage the fragile ecology of the park. Faced with the dilemma of how to control population numbers in a humane and publicly acceptable way, the park began contraception research in 1985. The outcome is a practical, relatively inexpensive, and publicly acceptable humane management tool that may have far-reaching use.

Researchers initially experimented with administering steroid hormones to reduce sperm count in males and prevent ovulation in females, but the technique did not show promise. Later, they inoculated 26 mares with an immunocontraceptive vaccine (porcine zonae pellucidae or PZP) that was 100% effective. The glycoprotein-based vaccine produces antibodies that block fertilization and did not interfere with pregnancies in progress or social organization. After 7 consecutive years of treatment, the only effects noted were failure to ovulate and depressed estrogen concentrations; in 120 mare-years of PZP contraception, only four foals have been born. The vaccine is easily delivered remotely and a single annual booster is adequate to continue contraception.

John Karish, NPS Chief Scientist of the Allegheny-Chesapeake System Support Office, is distributing copies of the report, *Management of Wild Horses by Fertility Control: The Assateague Experience* (NPS/NRASIS/NRSM-95/26), by Dr. Jay F. Kirkpatrick. Contact him at 209B Ferguson Building; University Park, PA 16802-4301; (814) 865-7974.

Global Change Research at Mount Rainier

David L. Peterson (NBS University of Washington CPSU) and Regina M. Rochefort (Mount Rainier National Park) have published the results of a Global Change Research Program study conducted at Mount Rainier. Entitled, *Temporal and spatial distribution of trees in subalpine meadows of Mount Rainier National Park, Washington, U.S.A.*, the study began in 1991 and examined the distribution and abundance of subalpine fir *(Abies lasiocarpa)* in five locations in the subalpine zone on Mount Rainier that represent variation in geography, climate vegetation type, and landscape position. They observed that the distribution and abundance varied during the past century in response to climatic variations at the micro- and mesoscale. Recruitment on the wetter west side of the park has been fairly continuous since about 1930, but has occurred only in short, discrete periods on the dry east side. Tree establishment is successful on the west side during warm, dry summers while cool, wet summers favor establishment on the east side. Vegetation type and landscape position also affect tree establishment. This dynamic relationship indicates that climate change could have a significant and rapid impact on regeneration of this and other high-altitude tree species.

Interested readers can find the 1996 article in Arctic and Alpine Research 28(1):53-59; reprints are also available from Rochefort; phone (360) 569-2211, ext. 3374.

Ferret Report Out

Biologists at Badlands National Park, South Dakota, have written a report on the black-footed ferret release program covering the period from May 1994 through September 1995. Nine chapters describe the restoration activities and include site preparation, release techniques, and post-release monitoring. Also included is the complete reintroduction protocol. A limited number of reports is available by contacting Badlands Wildlife Biologist Glen Plumb at (605) 433-2464 and asking for the report:

McDonald, P.M., P.E. Marinari, and G.E. Plumb, editors. 1996. Black-footed ferret reintroduction: Year one completion report, Conata Basin/Badlands, South Dakota. U.S. Forest Service. Wall, South Dakota. 136 pp.

Wisconsin CPSU Web Site Worth Checking Out

The Wisconsin Cooperative Park Study Unit (University of Wisconsin–Madison) now operates a fine World Wide Web site on the Internet *(http://www.emtc.nbs.gov/wicpsu.html)*. Its features presently include a list of the 1995 research projects undertaken by the CPSU in support of national park system areas of the Midwest Field Area, annotated flora references for 22 midwestern parks, searchable flora and lichens databases, and other related information.

Natural Resource Agencies and Social Values Explored

Craig Shafer, an ecologist with the NPS Natural Systems Management Office, recently enjoyed reading two papers by

Jim Kennedy, a professor of natural resource management at Utah State University. Presently serving a stint as Special Assistant to the Director of the Bureau of Land Management in Washington, D.C., Kennedy writes about natural resource management and social values, and has analyzed the integration of technically oriented natural resource managers into agency culture in the first paper. The second paper presents the results of a survey of several thousand employees of the U.S. Forest Service, probing their perceptions of agency priorities and its reward system. The analysis gives insight into what large organizations value most and how these values can be vastly different from those held dear by employees. The two papers are:

Kennedy, J.J. and J.W. Thomas. 1991. Exit, voice, and loyalty of wildlife biologists in public natural resource/ environmental agencies. Pages 221-238 *in* W.R. Mangun, editor. American Fish and Wildlife Policy: The Human Dimension. Southern Illinois Press. Carbonbale.

Kennedy, J.J., R.S. Krannish, T.M. Quigley, and L.A. Cramer. 1992. How employees view the USDA-Forest Service value and reward system. Presented at the 4th North American Symposium on Society and Resource Management, School of Natural Resources, University of Wisconsin-Madison, 17-20 May 1992. Unpublished.

Kennedy has written many other papers. Although he has not yet read them, Shafer suspects these will especially interest resource managers trained in the natural sciences, for Kennedy delves into social science issues in natural resource management. They include:

Kennedy, J.J. 1991. Integrating gender diverse and interdisciplinary professionals into traditional U.S. Department of Agriculture-Forest Service culture. Society and Natural Resources **4**:165-176.

Kennedy, J.J. 1988. Legislative confrontation of groupthink in U.S. natural resource agencies. Environmental Conservation **15**:123-128.

Kennedy, J.J., B.L. Fox, and T.D. Olson. 1995. Changing social values and images of public rangeland management. Rangelands **17**:127-132.

Kennedy, J.J. and J.W. Thomas. 1995. Managing natural resources as social value. Pages 311-321 *in* R. Knight and S. Bates. A New Century for Natural Resources Management. Island Press, Washington, D.C.

Kennedy spoke at the December Tucson meeting on ecosystem management (see the article on page 13) and recently presented two training sessions to new NPS resource managers at the Albright Employee Development Center. In the near future, he will be returning to Utah State University where he has worked for 25 years. Any potential readers who can not locate the papers are encouraged to contact Kennedy himself at (202) 208-3898; fax (202) 501-6718.

Indicators of Hydrologic Change Examined at Indiana Dunes

National Biological Service Research Scientist Doug Wilcox of the Great Lakes Science Center has published in the Natural Areas Journal **15**(3):240-248 a paper entitled, *Wetland and Aquatic Macrophytes as Indicators of Anthropogenic Hydrologic Disturbance.* Based on work conducted at Indiana Dunes National Lakeshore, Indiana, the paper discusses how hydrologic disturbances can affect wetland and aquatic macrophyte communities by creating temporal changes in soil moisture or water depth. Such disturbances are natural; however, human-caused changes in wetland hydrology may have negative effects on wetlands. Since plant communities respond to habitat alterations, observations of plant community changes may be used to recognize effects of hydrologic disturbances that are otherwise not well understood. A number of plants, including *Typha angustifolia* (narrow-leaf cattail) and *Lythrum salicaria* (purple loosestrife), are recognized as disturbance species; they are often found in roadside ditches, in wetland that have been partially drained, or in low areas that have been flooded. Other species commonly occur on mudflats exposed by lowering of water levels. In addition, wetland shrubs and trees invade or die as a result of draining or flooding. In more subtle terms, the relative composition of plant communities can change as a result of altered hydrology. Remote sensing (photointerpretation) and field vegetation studies, coupled with water-level monitoring, are recommended for gaining an understanding of hydrologic disturbances in wetlands.

Wilcox is also the editor of *Wetlands,* a quarterly journal concerned with all aspects of wetlands biology, ecology, hydrology, water chemistry, soils and sediment characteristics, management, and laws and regulations. Subscription and article submission information is available from the Society of Wetland Scientists; phone (913) 843-1235.

Environmental Software Described

Environmental Software Systems (ISBN 0-412-73730-2) by R. Denzer, G. Schimak, and D. Russell, consists of articles on software used in environmental protection and research. The book addresses the themes of environmental information systems; modelling and simulation; environmental management; decision support; distributed environmental information; artificial intelligence applications; and environmental data visualization. Published by Chapman and Hall, 115 Fifth Ave. New York, NY, 10003, the hard copy costs $110.50. It is 304 pages in length.

Ecosystem Geography

Robert G. Bailey, the U.S. Forest Service senior geographer and developer of a well-known ecoregion classification system used by many land managers around the world, has published a new book. Available from Springer Verlag (800-777-4643), *Ecosystem Geography* (1995) is a landmark contribution that brings the geographers' tools–maps, scales, boundaries, and units–to the study of ecosystems. The author has distilled more than two decades of research on ecosystem mapping and classification. His work has had a growing influence on how government and academic scientists are using ecological data to monitor biodiversity, manage land holdings, and interpret the results of climatic change. *Ecosystem Geography* features spectacular graphics, including diagrams, photographs, and abundant maps. It will be welcomed by ecologists, geographers, land and resource managers, and anyone involved in the study or management of landscapes and ecosystems. The book has been released in both softcover (ISBN 0-387-94586-5; $34.50) and hardcover (ISBN 0-387-94354-4; $69.95), and is 204 pages long.

The National Biological Service and NPS Science-Based Management:

Examining a static need in a dynamic relationship

By Rich Bachand

THE NATIONAL BIOLOGICAL Service (NBS) was created in October 1993 by U.S. Department of the Interior (DOI) Secretary Bruce Babbitt to provide independent and objective science for department bureaus. The agency is "to work with others to provide the scientific understanding and technologies needed to support the sound management and conservation of our nation's biological resources" (NBS Mission 1995).

In creating the NBS, most biological research, survey activities, and personnel of the eight department bureaus (U.S. Fish and Wildlife Service, National Park Service (NPS), Bureau of Land Management, Bureau of Reclamation, Minerals Management Service, Office of Surface Mining, U.S. Geological Survey (USGS), and Bureau of Mines) were combined in the new agency leaving their respective parent bureaus without an internal biological research staff. The National Park Service found itself with 183 fewer scientists and staff (Ombudsman Committee Report 1994). This coincided with the publication of the National Academy of Sciences report on *Science and the National Parks* (1992), a report that strongly urged fundamental changes in NPS structure and culture to effect a greater emphasis on scientific research in parks.

It is easy to understand how these events left NPS officials uneasy. The National Park Service had a new and clear mandate to improve the quality of its research at a time when it would lose jurisdiction of its research staff. This crossroads is where the National Park Service and its former scientists would unfold a new partnership.

Expert Panel

At the George Wright Society meeting in Portland, Oregon (April 1995), I served as chairman of a panel session entitled, "The Role of NBS in Meeting NPS Management Needs." This session provided one of the first opportunities to explore the new alliance between the two agencies. The expert panel offered a variety of perspectives and consisted of individuals with broad expertise in park research and resource management. They included Craig Allen (Scientist–Bandelier National Monument, NM), H. Ron Pulliam (Director) and Charles van Riper III (Scientist–Colorado Plateau Research Station) from the National Biological Service; and Bob Moon (Regional Chief of Resource Management for the former Rocky Mountain Region) and Karen Wade (Superintendent–Great Smoky Mountains National Park, Tennessee and North Carolina) from the National Park Service.

With the imminent transfer of the National Biological Service to the U.S. Geological Survey, I have highlighted insightful observations made during that discussion for consideration as the former NPS science program undergoes further change. The issues discussed during that session remain pertinent to current discussions and serve as a reality check in an effort to continue providing scientific information to park managers.

Opportunities

Panelist Bob Moon tailored his comments to the complexities of the simultaneous creation of the National Biological Service with NPS efforts to reorganize and reinvent itself. "At the same time the Park Service is reorganizing itself, we're trying to figure out how we're going to do science with NBS." Moon saw these changing times as a chance to move forward in improving the quality and accountability of research. Although positive steps were made toward more closely tying quality research with science-based resource management, pre-NBS science conducted in house was not "the good old days," and he said "the movement still had a long way to go." Separating research from the National Park Service provided the National Biological Service with an opportunity to act independently and to establish its credibility by providing science for management. "One of the problems we've had with past Park Service research in terms of credibility was accountability. I would encourage the NBS to build in a lion's share of accountability," Moon recounted.

Layers of Reorganization

Many concerns dealt with the reorganization the National Park Service went through both before and after the creation of the National Biological Service. Moon noted that research and resource management in the NPS had been coming together (as called for in the Vail agenda). Quality research had been getting underway and lending itself to a more science-based resource management program. When the National Biological Service was created, all this forward movement came to an unexpected crossroads. The transition left the National Park Service without an internal structure for tactical research or technical assistance (it would depend on the partnership with NBS) at a time when it was going through its own reorganization. "This was a reorganization where NPS research was never part of the discussion." He quickly added that the National Park Service is still responsible for conducting research and carrying out science-based management and that the National Biological Service is an organization to help them reach this goal. Moon warned, "None of us (referring to NPS) can have the... attitude to let the NBS do it, so [that] *we* don't have to worry about it."

Progressive Steps

The departure of park scientists to the National Biological Service greatly concerns Great Smoky Mountains National Park Superintendent Karen Wade for

many reasons. In a proactive manner, the park and the NBS Southern Science Center entered into a memorandum of understanding in 1994 to ensure a continuing working relationship between the two organizations and obtain commitments from scientists for their continued park research. "Since our very modest biological research capabilities were changing hands, my desire was to partner with the NBS and to assure the ongoing consultative relationship so important to the future...." Superintendent Wade continued, "My belief is that together we can do better than what we were doing before this relationship began."

The memorandum addressed many park concerns and fears resulting from the transfer of NPS science capabilities to the NBS. The park wished to ensure that a reduction in tactical research assistance would never occur, especially in a hypothetical scenario where its former scientists were assigned to other NBS priorities. Next, both agencies committed to maintain the park's long-term monitoring program. The memorandum assisted in doing that through mutual agreement to cooperate, resource sharing to gain additional support for the program, and information sharing.

NBS Through the Eyes of a Park Manager

Superintendent Wade expressed concern that the NBS does not place high enough priority on field stations and (in a prophetic moment) that the NBS would be absorbed into another organization rendering the possibility of more distant ties between the agencies. She believed that field stations have been staffed with devoted scientists, and desired to continue the strong relationship with former NPS colleagues who could provide unbiased, non-advocacy science to park managers. "If the NBS is going to be absorbed into another organization, we must retain our scientists and the wonderful rich reservoir of knowledge that we currently have."

Too Focused or Not Focused Enough?

One question raised was how parks would sustain funding for park-specific needs if NBS concentrated its scarce resources on global, landscape-scale, multiagency research. Similarly, NBS must strike a balance and remain flexible enough to deal with tremendously difficult generic issues like air quality. Can NBS flex enough to have a unit located in the middle of the country that serves Shenandoah, Great Smoky Mountains, and the parks of the east coast? Bob Moon declared that for the NBS to be successful it must continue to do tactical research and provide technical assistance, "for NBS that's a given."

A Place-focused Approach

Based in Bandelier National Monument, NBS scientist Craig Allen championed the idea of a place-focused approach where a national park (or public land or natural area) served as a focal point for long- and short-term inventory, monitoring, and research. He quoted the 1994 ombudsman committee report, *Solutions to Problems faced by former NPS Scientists transferred to the NBS* (van Riper 1994), that stated, "Many [scientists] had a long-term tie to a specific park in which their role usually transcended basic research to encompass information transfer, science adviser, program facilitator, and activities fundamental to maintaining long-term integrity of the national park resources and ecosystems." He noted that what held this together was the focus on a place, the landscape, and the continuity of the relationships between the people and the place.

Dr. Allen stated that a positive aspect about the NPS research program, albeit small in pre-NBS times, was that researchers were on site in the parks working with managers. In these cases, scientists were closely integrated with management objectives. He also suggested that his role at Bandelier spanned a continuum between spending a quarter of his time monitoring, a quarter dealing with management issues including information transfer, a quarter supporting and catalyzing the work of other researchers, and a quarter conducting new research. "I can't think of just chopping and dichotomizing the individual [areas of work emphasis]; it's maybe more like a soil texture triangle, where for any given issue, you're in some interconnected place...," Allen stated. He continued that many scientists in a similar position assist in synthesizing the work of other people and serve as an interface between research and management.

Lending evidence to Wade's earlier comments regarding the commitment and allegiance of a scientist to the "place" (i.e., park, monument, natural area), Allen

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NBS-USGS Merger Update

On March 22, 1996, NBS Director Ron Pulliam announced that the NBS-USGS merger was in progress and would be completed on or before October 1, 1996. At that time, NBS biological science and related activities will become the Biological Resources Division (BRD), a fourth division within USGS (USGS currently consists of the Geologic Division, Water Resources Division, and the National Mapping Division).

A transition steering team composed of NBS and USGS representatives established four issue subcommittees (science, management, administration, and information and technology) that worked toward a June 1 final report that will serve as a final plan for the NBS-USGS consolidation. Under the flag of USGS, the BRD will continue serving the biological research needs of DOI agencies with the potential for increased funding in fiscal year 1997 to address priority science needs of the DOI land management bureaus. This new initiative would expand research assistance by means of tactical research, inventory, monitoring, mapping, and data support. Combined with a commitment by the National Park Service to provide matching support for NBS NRPP (Natural Resource Protection Program) work, hope for a continued emphasis on a strong science-based approach to land management is foreseeable.

noted that through time, and perhaps by default, he had become "the local expert" on the ecology of not only Bandelier, but also of the larger landscape around the monument. To a degree, each scientist becomes the institutional memory and source person for a variety of information concerning local natural resources. He emphasized that he did not think his situation was unique, because it was not uncommon for many park based researchers to spend a good part of a career in a given park producing similar local expertise.

National Biological Service Director H. Ron Pulliam emphasized his strong belief in the importance of having NBS scientists in the parks, though he did not feel it would be possible in the near future to cover each national park in the country. His rationale for increased focus on parks was the lack of basic information concerning the resources in national parks and monuments. He cited a recent publication by NBS scientists (Stohlgren et al. 1994) that examined the status of biotic inventories in parks. "It really pointed out our fundamental ignorance about park resources. We don't have a reasonable inventory of even the birds, mammals, and vascular plants in the parks, much less the [reptiles and amphibians] and other less charismatic organisms." He noted that there is even less understanding of the changes affecting the biological resources.

As an indication of the NBS commitment to providing science in national parks, Director Pulliam intends to continue implementing the recommendations of the 1994 ombudsman committee report. The report proposed establishing a network of long-term NBS research sites including national parks as focal points, dedicating a portion of NBS funding to deal with NPS research issues, continuing to waive NBS overhead on NPS funded projects, and other park oriented initiatives.

Research Grade Evaluation

Dr. Allen brought up one issue that was not addressed in the ombudsman report. He discussed how research grade evaluation status puts pressure on park-based NBS scientists to think more narrowly about their roles. "Within NBS, we could receive less credit for doing the things the park wants us to do." He spoke of an experience where one NBS scientist was told by the chair of his research grade evaluation panel that the kinds of local interactions with management (information transfer, coordinating research, etc.) were "serving as anchors to a career with otherwise great potential," clearly highlighting the tradeoff between management support and publishing activities. "I think it's a very real problem. There is persistent tension between how you're evaluated under research grade evaluation status (i.e., a publishing record) and the realities of a park-based scientist." Although all would agree that publishing builds scientific credibility, some balance must be made that realizes the realities of a park-based scientist. Some of these concerns are being discussed as part of the current transfer of NBS scientists to USGS.

Final Thoughts

In closing, the panelists called for leaders to ensure that the National Park Service and National Biological Service take active roles in making the partnership work. Charles van Riper suggested that "the parks should take their planning documents down to [the] local NBS office, wherever it may be, and say 'Here's what I need done, do you have anybody that can do this?'" He felt that when the next call for NBS research proposals would come out, those scientists could show an identified research need, and leverage that in a way where one could say, "Look, I'm meeting a client need," thus aiding in getting the project funded. Van Riper insisted that parks use their planning documents and was adamant that the National Park Service not be charged overhead. Park officials express hope that positive trends like this will continue as NBS merges with the USGS.

Perhaps one of the most important points to come out of the discussion was the need to solidify the NBS-NPS partnership. "How do we make visitors aware of the research challenges that directly relate to wise management?," Superintendent Wade asked. She expressed that research programs need more visibility so that the public could take that awareness to their representatives and make them realize that we need more research to more wisely manage and protect our nation's resources. "NBS needs to become a household word. If we can make a positive connection between the NBS as the organization in parks doing our research, we will have overnight visibility for our research needs and both organizations will benefit."

It is hard to predict what the most appropriate or even practical model is for science in the parks and science-based park management. Prior to the NBS, science in parks was on an upswing through the National Academy of Sciences report, issuance of the NPS-75 Inventory and Monitoring Guideline, and the beginnings of nationwide ecosystem research initiatives like the Global Change Research Program. However, as Bob Moon noted earlier, "Pre-NBS research was not the good old days."

As 1996 progresses with change and uncertainty swirling about us, the relationship between science and the parks has become as dynamic as the changing research needs. However, the need itself remains constant. Often, times of change present the greatest opportunity to reinvent, improve, or create something positive. As the NBS (soon to become the Biological Research Division within USGS) undergoes its transfer to the USGS and the new relationship to the NPS continues to unfold, each agency must assume the responsibility of procuring a sound, science-based management of natural resources in our parks.

Literature Cited

National Academy Sciences. 1992. Science and the National Parks. National Academy Press, Washington, D.C. 122pp.

Stohlgren, T.J., J.F. Quinn, M. Ruggiero, and G.S. Waggoner. 1995. Status of Biotic Inventories in U.S. National Parks. Biological Conservation 71:97-106.

Van Riper, C. 1994. Ombudsman Committee Report: Solutions to Problems Faced by Former NPS Scientists Transferred to NBS. A Report to the Director of the USDI National Biological Service. 14pp.

Rich Bachand is an Ecologist studying climate change in forested ecosystems with the National Biological Service. Stationed at Rocky Mountain National Park in Estes Park, Colorado, his research interests also include landscape ecology and dendroecology. His phone number is (970) 586-1211; fax: (970) 586-1392; e-mail "richardb@niwot.cnr.colostate.edu".

Ecological Stewardship Workshop

The National Park Service takes a step toward ecosystem management

By Craig L. Shafer

Last December, 400 participants from numerous federal agencies and nongovernmental organizations took part in a bold workshop entitled, "Toward a Scientific and Social Framework for Ecologically Based Stewardship of Federal Lands and Waters." The groundbreaking gathering, held on the outskirts of Tucson, Arizona, sought to develop a framework for implementing an ecosystem approach to managing federal lands and waters. Hosted by the University of Arizona, the U.S. Forest Service explained that the meeting aimed at shortening the 10-15 year development time historically needed to make routine use of scientific information in the management of federal lands. The product will be a compendium that outlines the options and alternatives and documents the scientific foundation for ecosystem management. According to the Forest Service, the framework is not intended to provide prescriptive solutions for individual sites or places, but will provide the foundation for the development of agency implementation plans and strategies.

Planning the Workshop

The workshop was a logical step in the progression toward ecologically based land and resource management. In 1994, the Congressional Research Service, the President's Commission on Sustainable Development, and the Interagency Ecosystem Management Task Force each added to the development of ecosystem management approaches on federal lands. This gathering built upon these earlier efforts.

This event was the brainchild of the U.S. Forest Service Chief Jack Ward Thomas, with planning and logistics carried out by Robert Szaro and William Sexton, also of the agency. Many agencies participated in planning sessions around the country to devise how the conference should be organized and what it should cover. This included the National Park Service, which fully endorsed the event. The NPS involvement was coordinated by Natural Systems Management Office biologist John Dennis and Agate Fossil Beds Superintendent Ruthann Knudson; additionally, the National Park Service held periodic meetings at the conference to assess its involvement. Many sponsors also contributed to the success of the conference. They included the National Fish and Wildlife Foundation, Kendall Foundation, Pinchot Institute for Conservation, and Pew Charitable Trusts, to name a few.

Products

The 10-day workshop centered on synthesizing existing scientific knowledge (including social sciences, economics, and legal considerations) and corresponding practical management experience on 30 key topics related to ecosystem stewardship. Each morning, selected *science team* authors delivered summaries of key points in the development of their papers. In the afternoon, *management team* authors focused on the successes, promising options, and failures related to the corresponding science topics. Participants contributed ideas in the afternoon management breakout sessions for the benefit of the management team authors. The result will be two parallel papers on each topic: a synthesis of existing scientific knowledge of the topic and a practical treatment of management experience in implementing these concepts on federal lands. The book containing these papers is being written and is expected to be published by a major university press.

Experienced Participation

A diverse group including the U.S. Fish and Wildlife Service, U.S. Geological Survey, National Biological Service, Boise Cascade, Weyerhauser, Woods Hole Oceanographic Institution, Oak Ridge National Laboratories, and the Conservation Fund, and many others, participated in the workshop in hopes that they could make a difference in furthering ecosystem management. The science team authors included many luminary figures from academia, government, conservation organizations, and industry. The management team authors came mostly from the U.S. Forest Service, Bureau of Land Management, and National Park Service. As the lists in tables 1 and 2 on page 14 attest, the National Park Service is participating in more than two-thirds of the 30 writing teams by providing both management and science team authors.

Agency heads also attended portions of the workshop. For example, the NPS Director and Deputy Director addressed participants, and ten top managers, including members of the NPS National Leadership Council, attended the end of the gathering. Near the close of the workshop, many agency heads, including those from the Bureau of Land Management, U.S. Geological Survey, National Biological Service, U.S. Forest Service, and National Park Service, signed a joint agency statement reflecting common ground. Deputy Director John Reynolds in a talk and subsequent memorandum to the National Leadership Council outlined immediate NPS follow-up to the agreement. More specific recommendations derived from the meeting will continue to be adopted.

Conclusion

Miraculously, this all happened within 8 months of the first major workshop planning session. Those involved in its planning thought it could never happen in such a short time–but somehow, it did! Why? Probably because it had to. The Forest Service said that this was the only timetable available to them. We also feared the possibility of political interference. Fortunately, no problems of this nature occurred.

The event helped demonstrate how natural and social science, history, and law are all components of ecosystem management. Such insights and integration will

Continued on page 14

Workshop continued

be provided on paper and although much work lies ahead to produce the final volume, the process is in motion. Managers will be able to use the detailed reference of over 60 scientific, management, and case study papers. However, the real test of the conference will come later as federal agencies and other land holders begin to implement some of the ideas discussed in Tucson.

Getting Involved

The process being used to exchange ideas and compile the written reports is provided on the Tucson workshop home page on the World Wide Web. The page may be accessed through the U.S. Forest Service home page or directly at *http://www.fs.fed.us/eco/workshop*. It includes a summary of the process, list of science and management topics, operating plan (including author team members), and both the science and management chapter outlines developed in Tucson. Many science topic papers were already in draft at Tucson and are available for review and comment.

Craig Shafer is an ecologist with the WASO Natural Systems Management Office. His phone number is (202) 219-8934 and his e-mail address is "craig_shafer@nps.gov".

Table 1. NPS Management Team Authors

Author	Affiliation	Topic
William Anderson	National Capital Field Area Office (202-342-1443)	Cultural values/resource use
Jennifer Bjork	Cumberland Island National Seashore (912-882-4336)	Decision support
Steve Cinnamon	Great Plains SSO (402-221-3437)	Shifting human use
Brien Culhane	Everglades National Park (305-242-7700)	Regional cooperation
Muriel Crespi	Archeology and Ethnography Program, WASO (202-343-8156)	Cultural values/resource use
Joan Darnell	Alaska SSO (907-257-2648)	Legal perspectives
John Dennis	Natural Systems Management Office, WASO (202-208-5193)	Ecological functions; Scale phenomena
Mary Foley	New England SSO (e-mail—"mary_foley@nps.gov")	Land condition over time
Rick Harris	Curecanti National Recreation Area (970-641-2337)	Ecological classification
Ron Hiebert	Midwest Field Area Office (402-221-3461)	Population viability; Uncertainty & risk assessment
Anne Hitchcock	Museum Management Division, WASO (202-343-8138)	Data management, collection, and inventory
Dan Huff	Intermountain Field Area Office (303-969-2651)	Human role
A. Trinkle Jones	Western Archeological and Conservation Center (520-670-6501)	Heritage management
Donna Kostka	National Center for Recreation and Conservation, WASO (202-343-3669)	Social system functions
Ruthann Knudson	Agate Fossil Beds National Monument (308-668-2211)	Human role; Ecological economics
Jean McKendry	University of Idaho CPSU (208-885-7129)	Case study—Columbia River
Susan Mills	Alaska SSO (907-257-2573)	Stewardship, consensus processes
Earl Neller	Kalaupapa National Historical Park (808-567-6802)	Cultural values/resource use
Kathleen Picarelli	Chesapeake & Allegheny SSO (215-597-1628)	Regional cooperation
Richard Ring	Everglades National Park (305-242-7700)	Restoration & maintenance; Case study—South Florida
Dave Ruppert	Rocky Mountain SSO (303-969-2879)	Heritage management
Ray Sauvajot	Santa Monica Mountains National Recreation Area (818-597-1036)	Ecosystem and landscape diversity
Craig Shafer	Natural Systems Management Office, WASO (202-219-8934)	Ecosystem and landscape diversity
Page Spencer	Alaska SSO (907-257-2625)	Disturbance and temporal dynamics
Howie Thompson	Denver Service Center (303-969-2461)	Public expectations/shifting values
Gary Williams	Natural Resource Information Division, NRPC (970-225-3539)	Monitoring and evaluation

Table 2. NPS Science Team Authors

Author	Affiliation	Topic
Don Calloway	Alaska SSO (970-257-2408)	Social/cultural classification
Steve Cinnamon	Great Plains SSO (402-221-3437)	Shifting human use
Muriel Crespi	Archeology and Ethnography Program, WASO (202-343-8156)	Cultural values/resource use
Dan Huff	Intermountain Field Area Office (303-969-2651)	Land condition over time
Rebecca Joseph	New England SSO (617-223-5056)	Social/cultural classification
Ruthann Knudson	Agate Fossil Beds National Monument (308-668-2211)	Human role
Gary Machlis	University of Idaho CPSU (208-885-7129)	Human ecosystems introductory book chapter; workshop summary

ECOSYSTEM STEWARDSHIP

WHAT DOES IT MEAN?

By Ron Hiebert

CRAIG SHAFER DESCRIBED the format of the Tucson Ecosystem Workshop. As he stated, we do not know what the benefits or outcomes of this exercise will be. We hope written products will communicate to scientists what managers need and encourage managers to engage scientists in the decision making process. All National Park Service participants share the responsibility to incorporate what was learned into everyday park operations, planning, environmental education, and training. Following I give my impressions of what the Tucson workshop was all about, the lessons I extracted, and how I feel it applies to the way in which the National Park Service conducts business.

To me, the message of the workshop was change. Not so much change in what we do but change in how and why we do it. Ecosystem management certainly is not a new concept for the National Park Service. We have long professed that we manage for the whole system rather than for individual components. We say we recognize humans as an integral part of the systems we manage and that societal, cultural, and natural resources are interrelated. But, how often do we approach problems on this premise? Treating these parts separately often does not the whole make.

Ecosystem stewardship is about scale, both spatial and temporal. The National Park Service recognizes that parks are not islands and that they must be managed within the context of their regional landscape. It is less routine to strategically consider the role of a group of parks in a regional scale such as the Ozark Highlands or the Great Lakes Basin, the role of the park system in preserving national biodiversity or the role of parks in providing habitat for neo-tropical migratory birds in North America. On a temporal scale, the National Park Service has put forth a concerted effort through such endeavors as the Vail Agenda to look at our changing role and how we must change to meet new challenges into the future. This kind of thinking needs to be scaled down to the cluster and individual park level more consistently and objectively.

The workshop also forced me to reexamine the meaning of stewardship, what it means to the federal land manager and specifically to us in the National Park Service who have been entrusted with stewardship of the nation's crown jewels for future generations. This is an awesome responsibility. We must, on a routine basis, find and apply the best information available in making management decisions. All of us must continue to hone our skills and keep abreast of new tools and technologies. Finally, we must involve the public in a meaningful way in park management. After all, they are who we serve.

The meeting also reemphasized the need for effective teamwork between managers and scientists and adoption of adaptive management principals. Managers need to engage scientists in the decision making process in ways that do not compromise their objectivity. Scientists need to be open to engaging in decision making to bring the best information to the table. This is a real challenge in our present structure with our former researchers now being transferred to the U.S. Geological Survey.

Further, we must recognize that "nature is dead." That is to say that the concept of systems uninfluenced by humans is now a myth. Therefore, it is up to us to define what we want the future condition of each park to be, develop a plan on how to get there, and apply evaluation criteria to see how we are doing. Simply saying our goal is to manage to protect "natural processes" will not do anymore.

Finally, management of parks will never again be as it was in the past. The public is no longer satisfied with the answer that we are doing it this way because "that's our policy." If it is perceived that a proposed action may be controversial, we must make the effort to explain to park users the rationale of the policy and why we believe that action should be taken. We must also be armed with solid scientific data to support our decisions. For example, if one wishes to remove feral horses, which park users love, the park must effectively communicate the NPS policy concerning exotic species and have solid scientific data to document the impacts the feral horses are having on park resources. Then, we must be prepared to seek a mutually acceptable solution to the problem (see the cover story on FACA).

The Ecosystem Stewardship Workshop was about change. Not so much change in what we do but in how we do it. As stated by the Director of the U.S. Forest Service in his opening remarks at the conference, we must "change or die."

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Continued from cover

Figure 2. The negotiated rulemaking sessions resulted in a new regulation that closed a significant portion of the plover nesting beaches to off-road vehicle use. Elsewhere, ORVs are still restricted to a nonsensitive corridor, marked with stakes.

The Issue

To generalize, ORV user groups feel strongly that they should be able to drive the entire outer beach when the plovers are not present as they did before the seashore was establish in 1961 (fig. 2). Conversely, the environmental groups feel that all ORVs should be banned from the beaches altogether. Many groups feel the answer is somewhere in the middle. The National Park Service, using the existing limited science on ORV use and resource impacts, and previous legal actions, feels that controlled, regulated use of ORVs on limited sections of the outer beach is not inappropriate, but that the majority of the outer beach should be vehicle free and that ORVs are not appropriate in sensitive resource areas (inner dunes, wetlands, marsh).

The objective of negotiated rule making is to *front-load* controversy by getting everyone involved in the decision from the beginning, and acknowledging (if not resolving) all issues and concerns. The process brings all interested organizations into the process and charges them with developing a common solution. This process is used by many federal agencies, most notably the Environmental Protection Agency (EPA), but this was the first time the National Park Service used it to make a rule that will be published in the Code of Federal Regulations (CFR). With recent criticism that federal land management agencies are facing for making isolated decisions, for example, we see this process as an important and growing tool.

The Process

Negotiated rule making is authorized under the Federal Advisory Commission Act, which provides for formal meetings to be open to the public. Meeting notices are published in the *Federal Record*. A public comment period at the end of each day is required as part of the process and those not in attendance can submit letters to be included in the record.

We began by identifying 23 groups (the maximum allowed is 25, although 6-7 is more common) that had a long-term interest and involvement in this issue. The organizations included state agencies, the six towns that the seashore is located within, ORV user groups, environmental groups, federal agencies, and tourism and preservation groups. Each organization selects one person to represent them at the table. These representatives are the only participants in the formal discussions, and all are equal, including the NPS representative.

To avoid unbalanced votes, we managed the negotiated rule making as a consensus process giving each representative a veto). This approach helps get people out of their entrenched positions, pushes them toward the edge of what they can agree to, and gets them thinking creatively. A "threat" can also be used to create a further incentive to participate. In our case, we made the initial statement that the NPS would be developing a new regulation for off-road vehicles if negotiation failed. Either the regulation would be developed by the group, or it would be developed by the National Park Service with the ideas, information, and creativity gathered from the group.

The advantage of this process for the National Park Service, regardless of whether the group reached consensus on a regulation or not, was that every issue, idea, and concern was heard by all sides. Furthermore, the National Park Service was no longer the enemy, but was a participant just like the others. If we were to reach consensus, we made a commitment to publish that regulation in compliance documents and the *Federal Register* as our preferred alternative.

The Federal Advisory Commission Act not only facilitates the process, but also in our case created some challenges in getting it underway. For example, our rulemaking sessions began only after the process had been cleared, some 2-3 years after the idea was first proposed. Another delay was that all organization representatives (as opposed to the organizations party to the process) had to be appointed by the Secretary of the Interior. After the first meeting, one organization removed its original appointee and selected a new one who they felt better represented their views. This created a scramble, for the Washington staff had to get the new appointee approved within a very small window of opportunity. If the National Park Service is going to use negotiated rule making regularly, it would be very beneficial if the process and paperwork associated with it could be streamlined.

Professional negotiators, contracted through an EPA *indefinite quantities* contract, ran both the formal sessions and the advance meetings with each organization. The $64,000 budget limited the formal sessions to just three, 2-day meetings. These were spaced a month apart to allow the representatives time to make sure that they were committing to things that their organizations could support and, very importantly, to allow time for behind-the-scenes interactions and negotiations. This is where much of the real work happens.

Preparation Vital

The most difficult NPS decisions and thinking had to be done before the process began. We used the time between meetings to refine philosophies, determine our boundaries on issues, and consider new suggestions. It is important that every angle and approach be explored, even undesirable ones, so that the NPS position, at least in public, is unified. The NPS representative must be sure of these boundaries during the sometimes heated and demanding exchange that takes place in the negotiation room. Thus, preparation is key to the process.

Normally, the process would start from ground zero. However, because of the limited number of meetings, the professional facilitator asked us to be prepared to share a *straw dog* or unofficial position to initiate discussion. To develop this, we first assembled a wide variety of park staff. We analyzed every aspect of the existing regulation and brainstormed possible rewrites. This included considering alternatives that would not have been in our plan, if we had been developing it independently. Finally, we threw out all the options we could not live with.

While developing the position document, we needed to keep it to ourselves until we could formally present it in the first session. We did not want the plan to get out, have an attack developed opposing this plan, then find ourselves in the very human position of defending a plan that we had developed specifically to provoke discussion, rather than to identify our idea of the best solution. This was easier said than done. The very need to keep the document private prevented the entire staff from participating in these first discussions. This was a problem and we should have done a better job of getting the staff to understand the process and how they would be involved.

We also needed to collect and organize relevant data, files, decisions, and past research on the issue in advance of the meetings. This information had to be synthesized, analyzed, and distilled so the staff was aware of the history of the issue. The scientific reports and data helped identify what separated the acceptable options from the unacceptable. The representative had to be able to explain to the committee the important points and ideas contained in these documents so that everyone could understand them.

Despite our preparation, we found that data often got in the way of the negotiation process. It was easy to get into a battle of "my expert" versus "your expert." Mountains of data and reports can overwhelm the group and the process, because some participants do not have access to expert information or may not understand the science behind the information; also, the claims of who has the better information, the correctness of the scientists, or the interpretation of the works can come into question. This creates the danger of raising tempers, because there is no way of resolving these issues among laypeople, and moves the discussion away from the central negotiation points. Our approach was to quickly disseminate scientific information, but only when necessary.

Between the second and third sets of meetings we put forward our first draft proposal, which was developed by a much larger circle of staff. This process was very much a parkwide, and in some respects a servicewide, effort. While just one person spoke for the National Park Service at the table, an enormous support team was behind the proposal. The team participated in numerous discussions between meetings, developed draft rules, reported the institutional knowledge on issues, and served as the reality check on the feasibility of different scenarios. Washington staff moved along the mountains of paperwork and requirements associated with FACA and reviewed draft proposals; the regional solicitor's office reviewed draft proposals and legal issues. Phone calls, e-mail messages, and discussions with other NPS areas around the country looked at their ORV issues and concerns.

Summary

The National Park Service has been accustomed to making decisions, plans, and policy after consulting staff or other federal agencies; however, we must improve our ability to communicate with state and local agencies, critics, and supporters, and learn to listen to their concerns and issues. We need to involve and be involved with our local communities and agencies, and we need to work together on issues of mutual concern rather than always seek public comment in traditional forums that keep us separate and above our critics. Although it promotes listening to our critics and involving them in the decision making process, negotiated rule making does not suggest that we abdicate our responsibility to protect resources or ignore the NPS mission. It simply requires that we not let resource preservation become a way of eliminating input or ignoring solutions developed by others. It requires us to be up front about our boundaries and to clarify a range of acceptable solutions. We found it to be a useful tool.

Epilogue

On the sixth and final day of negotiations, the ORV user groups and the environmental groups had a private 6-hour caucus. In the end, all 23 groups agreed to a new ORV regulation that closes a significant portion of the current ORV corridor, which is a prime plover nesting area from April 1 through July 20. The regulation also opens both a section of outer beach not currently available for ORV use (for night fishing only) and another small section of beach for general ORV use. Some small (two to three car) undeveloped parking lots will be established behind the primary dune for parking to accommodate fishing access. The new regulation also formalizes and recognizes the role that ORV users, serving as volunteers, play in education and resource monitoring and preservation.

PS

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Linda Canzanelli is Deputy Superintendent and Michael Reynolds is Chief of Natural Resource Management. Both are at Cape Cod National Seashore, Wellfleet, Massachusetts. Each is accessible over NPS cc:Mail or by e-mail at "firstname_lastname@nps.gov". Additionally, the park phone number is (508) 349-3785; fax (508) 349-9052.

Aster yukonensis Range Extension in Northern Alaska

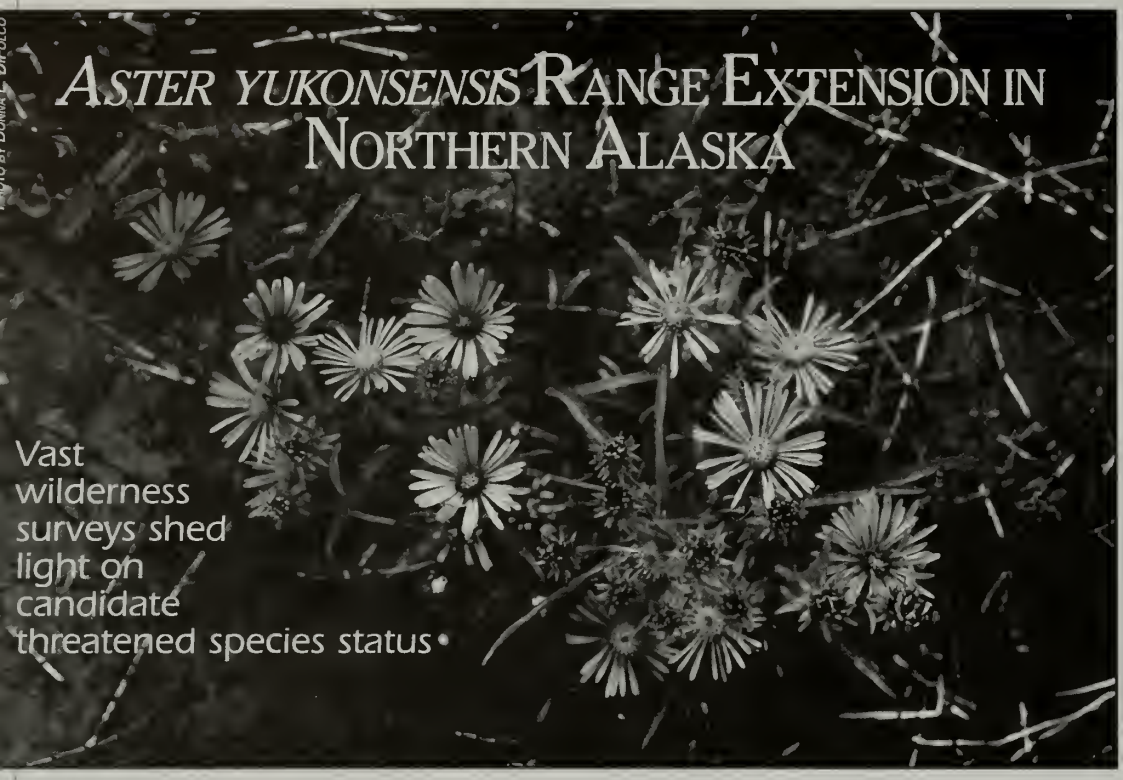

PHOTO BY DONNA L. DIFOLCO

Vast wilderness surveys shed light on candidate threatened species status

Figure 1. Yellow centers and violet petals characterize the Yukon aster, a candidate threatened plant species in Alaska. Recent surveys in Gates of the Arctic National Park and Preserve revealed that the plant is more widespread than previously thought.

By Donna L. DiFolco

In July 1993, NPS resource managers discovered a small population of *Aster yukonensis* (fig. 1) on an island in the Middle Fork of the Koyukuk River in northern Alaska, within several miles of the only documented location of the plant in the United States. This discovery spurred interest in searching for more populations of the plant in neighboring Gates of the Arctic National Park and Preserve (fig. 2). The NPS staff at Gates of the Arctic have since found more populations of the Yukon aster along the Middle and North Forks of the Koyukuk River. Resource managers have also identified the plant in the Kobuk Sand Dunes in Kobuk Valley National Park.

The Yukon aster, a violet petaled, thin leafed aster of the Composite family, is currently listed as a candidate species, category 2, for the threatened and endangered species list. Knowledge of the plant's range and status is not yet fully understood, hence its classification as a category 2 species. Until recently, the Yukon aster had been known to occur only in southwestern Yukon, Canada, and at one location on the Koyukuk River, Alaska. The National Park Service is mandated by the Endangered Species Act to protect threatened, endangered, or candidate species of plants and animals within the areas it manages; Gates of the Arctic National Park and Preserve has undertaken the task to locate and map *A. yukonensis* within its borders to meet this mandate.

In late July, 1994, a resource management crew surveyed approximately 58 km (36 mi) of the Middle Fork Koyukuk River, searching for the plant on every gravel bar (fig. 3) on the park side of the river (generally the north bank) and each island that was mostly on the park side. For the first day-and-a-half of the survey, we searched in vain. Finally, we came across the first population of *A. yukonensis* on a gravel bar of the park border.

Once we located the first specimens, we walked from one end of the gravel bar to the other in parallel transects. We counted each *A. yukonensis* seen on the gravel bar, from the thick organic mat of the forest edge to the sparsely vegetated strip nearest the river. The first specimens located were examined carefully by looking for the densely glandular phyllaries (the narrow, leaflike bracts at the base of the flower) to confirm identification. After this, we used macroscopic features, such as the long, narrow clasping leaves, to identify the species more quickly, and to distinguish it from other species (mainly *A. sibiricus*).

Some river bars harbored so many of the Yukon asters that it was impossible to count them all. In these high density areas, we dispersed across the gravel bar, each person searching a different section and counting asters. Then the individual counts were combined into a minimum estimate for the total site count.

The search turned out to be much more successful than expected, as we found Yukon asters growing on nearly every gravel bar in a 40-km stretch (25 mi) of the river bordering the park. Most sites had from 50 to over 400 plants on the gravel bars. Two sites supported at least 1,000 plants each. The plants seemed to prefer sites mainly where river silt had accumulated at the upper and lower ends of gravel bars and along sloughs.

Directly after the confluence with the North Fork Koyukuk, we found only a few Yukon asters. The sudden disappearance of the large populations was puzzling. A change in soil type could be one reason for the decline. Less silt accumulates just below the confluence than along other parts of the river because the sedimentation regime has been altered by North Fork river water. Farther down river from the confluence, population sizes increased again, with counts in the 50-150+ range. These populations were made up of scattered individuals, much like the popula-

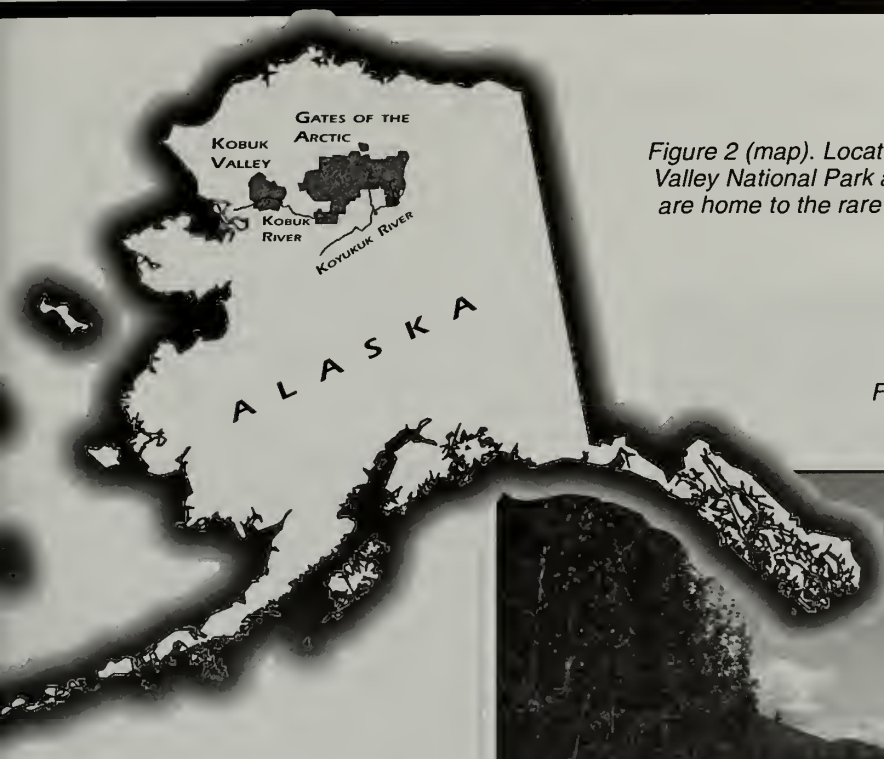

Figure 2 (map). Located north of the Arctic Circle in Alaska, Kobuk Valley National Park and Gates of the Arctic National Park and Preserve are home to the rare Yukon aster.

Figure 3 (photo). The aster grows along gravel bars, such as this one located on the Koyukuk River in Gates of the Arctic.

PHOTO BY DONNA L. DIFOLCO

tions where the first flowers were discovered. This type of distribution suggested that either the species was just getting established on the gravel bar or the soil type was not optimal.

About a month after the survey, a flood swept through the area, rivers swelling high above the 100-year flood water line. Concern that the flood wiped out the tenuous population of Yukon aster along the Middle Fork Koyukuk was relieved when biologists on a bird survey the following spring confirmed that some plants had survived the big flood.

In 1995, staff surveyed the North Fork Koyukuk River for the species, mapping more, albeit few and scattered, populations of the Yukon aster. Resource managers found 13 populations along the North Fork, totalling less than 300 individuals. We do not know whether more substantial populations existed before the 1994 flood or not. A second survey of the Middle Fork to reexamine gravel bars that supported sizeable populations of the aster might reveal whether the flood affected the flowers. If major floods have deleterious effects on populations of these rare plants, then this may explain why the plant is uncommon.

While *A. yukonensis* was being mapped on the Middle Fork Koyukuk River in 1994, it was also being discovered in the Great Kobuk Sand Dunes along the Kobuk River in Kobuk Valley National Park (fig. 2). National Park Service personnel in Kobuk Valley found 23 populations of *A. yukonensis,* totalling about 1,500 individuals (Hunt, NPS, personal communication). The habitat types where the Yukon asters were found in the Kobuk Sand Dunes were similar to the silty-sand gravel bars they seemed to prefer along the Koyukuk River. The Kobuk Sand Dunes populations, found mainly in dune depressions, were not as robust in terms of density and numbers of individuals as some of the Middle Fork Koyukuk populations, but seemed to be better developed than the North Fork populations. Differences in soil type and the length of time since the last environmental extreme (e.g., flood or drought) may be reasons for variations in population densities.

The past two summers of field work have greatly expanded the known range of *A. yukonensis* in northern Alaska. The plant is likely to occur in other areas as well. In summer 1995, Yukon asters were reportedly seen far into the mountains along Agiak Creek, a tributary of the Hunt Fork John River. As we gradually survey the vast areas of Gates of the Arctic National Park and Preserve and inventory its resources, we will begin to more clearly understand the distribution of rare plants such as *A. yukonensis.*

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Landslides & Fossil Resources at Hagerman Fossil Beds:

A case study in landslide factor assessment

By Lawrence P. Growney

LOCATED 64 KM (40 MI) west of Twin Falls, Idaho (fig. 1), Hagerman Fossil Beds National Monument preserves abundant and diverse Pliocene-epoch fossils embedded in the banks of the Snake River. The quantity, quality, and variety of these 3-3.4 million year old fossils distinguish the monument internationally. Over 150 species, including mastodon, giant ground sloth, camel, bear, and the world famous Hagerman horse, have been preserved and identified in the Glenns Ferry Formation, which rises in cliffs to over 153 m (500 ft) above the Snake River.

Authorized in 1988, the park preserves the fossils and provides for paleontological research. However, landslides regularly disturb the fossils and endanger the safety of visiting researchers. Since 1983, landslides have decimated more than 2.7 million m^3 (3.6 million yd^3) of fossil-bearing material (Table 1 and fig. 2).

Concerned about this serious resource threat, park staff hypothesized that the landslides were the consequence of oversaturation of the Glenns Ferry Formation resulting from leaking, unlined, irrigation canals on the plain above the Snake River. Ironically, the park enabling legislation states that the preexisting water delivery system, which crosses the park, is "compatible and consistent with park purposes." However, for the monument to become a premier location for scientific study, we must be able to assure visiting researchers of a reasonably safe and productive research experience and preserve a coherent stratigraphic and depositional setting conducive to interpretation. To meet these goals, the park began a detailed landslide assessment process in 1993 to determine the factors resulting in the landslides and recommend solutions within the bounds of the legal mandates.

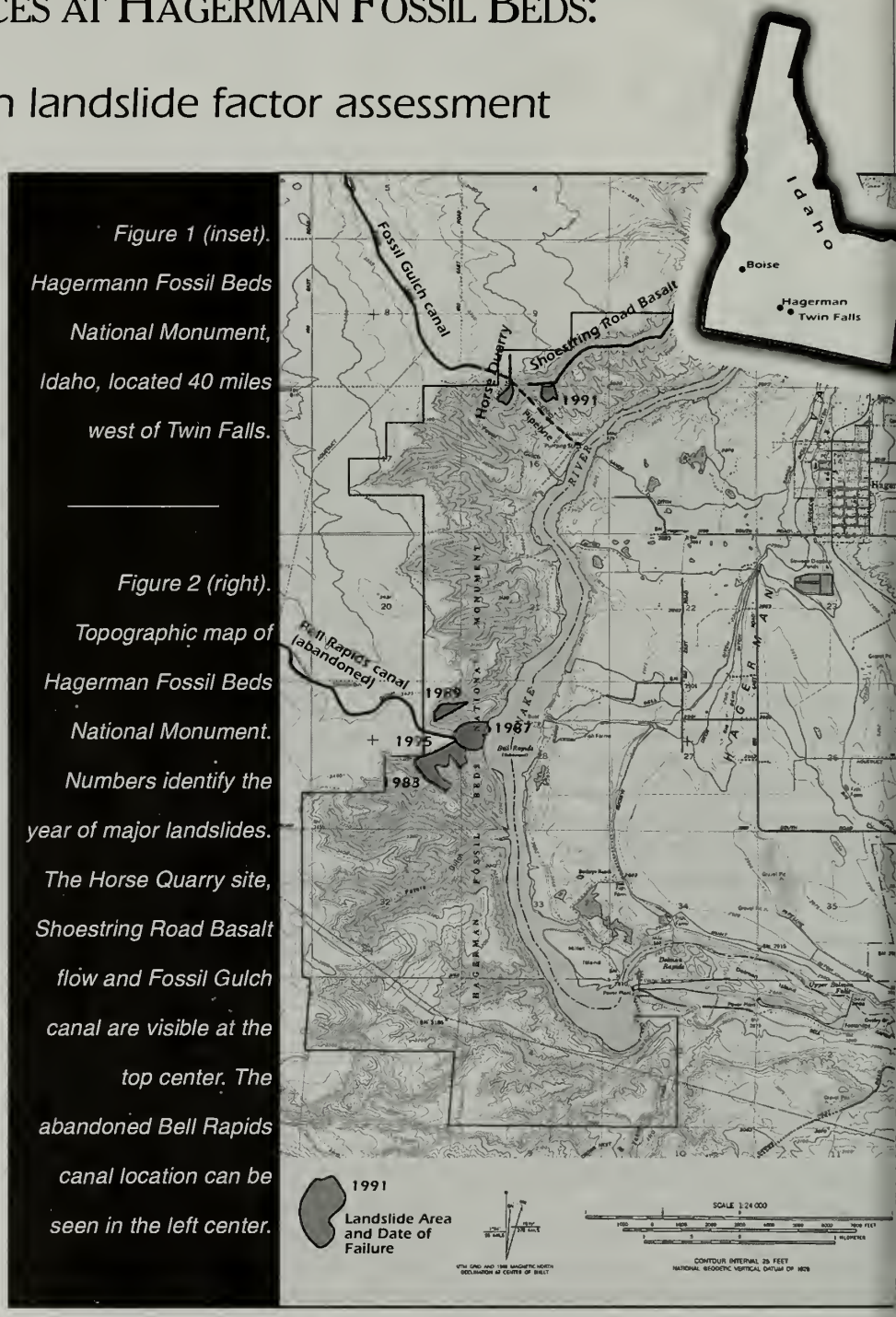

Figure 1 (inset). Hagermann Fossil Beds National Monument, Idaho, located 40 miles west of Twin Falls.

Figure 2 (right). Topographic map of Hagerman Fossil Beds National Monument. Numbers identify the year of major landslides. The Horse Quarry site, Shoestring Road Basalt flow and Fossil Gulch canal are visible at the top center. The abandoned Bell Rapids canal location can be seen in the left center.

Geologic Setting and Background

The fossil-rich Glenns Ferry Formation in the Hagerman area is composed of ashfall units and sediments deposited in lakes, rivers, and swamps during the Pliocene epoch 3-3.4 million years ago (Malde and Powers, 1972). A thin (<4.6 m or <15 ft) basalt flow crops out at the north end of the monument and is visible in the hillside northeast of the world famous Smithsonian Institution Horse Quarry (fig. 2). Known as the Shoestring Road Basalt, this flow is interbedded with the Glenns Ferry sediments about 122 m (400 ft) above the river.

The Desert Entry Act of the early 1960s, opened the plateau adjacent to what is now the national monument to farming (fig. 2). The Bell Rapids Irrigation District was created by the farmers to supply water for their needs. For more

than a decade, two pump stations moved nearly 51,000 acre-feet of water from the Snake River uphill 152 m (500 ft) through 48" diameter pipes to the plateau for distribution by canal (Anderson, 1995). Since a 1987 landslide that buried the Bell Rapids pump station (fig. 2), water to the irrigation project has been supplied by the Fossil Gulch pump facility. The pipeline from this pump station lies adjacent to the Horse Quarry and crosses over an extensive seepage zone.

From the Horse Quarry site, over 100 skulls and 30 complete skeletons have been recovered through past excavations. It is the most productive and scientifically significant locality for the species *Equus simplicidens* in the world. While the Horse Quarry site is open to visitors and researchers at the present time, this could change. Each year, nearly 500 acre-feet of seepage, and sporadic slope movement, occurs within a radius of 610 m (2,000 ft) of this site.

Assessing Landslide Factors

In 1994, we began a 3-year assessment effort to find a solution to the landslide threat. Using NPS NRPP (Natural Resource Preservation Program) funds, we first identified the fossil areas at greatest risk, and have begun to characterize the rocks, study the hydrology, and examine the soil strength of these areas. A key to accomplishing the work within the 3-year time frame has been to involve other public and private parties that have an interest in the Hagerman landslide issue (Table 2). Together we have shared our strengths and made quicker strides toward achieving our goals of minimizing landslides and their effects.

Results

Studies examining the rock types, and their interlayering, support the Malde and Powers findings (1972) that the local Glenns Ferry Formation is composed of layers (beds) of ashfall, lake, river, and swamp deposits, which dip gently to the south-southeast at about 3 degrees. It is important to note the distinction between dip of the beds and slope gradient. Dip of the beds is about 3 degrees while the slope gradients near landslide-prone areas are between 30 and 90 degrees. This is why seeps (and the landslides) occur on south- and east-facing slopes.

Nearly 75% of these beds are composed of very fine-grained particles, such as clay, which retard the downward flow of groundwater through the bed (Lee et al. 1995). When the water finds it easier to flow across the top of a bed, rather than through it, the bed is referred to as an *aquiclude*. The water held above an aquiclude forms a *perched aquifer*, or a body of groundwater occurring above the true water table. Young (1984) and Reidel (1992) have identified at least 4 perched aquifers within the monument.

Geophysical investigations of the perched aquifer system involved the use of geoelectric and seismic methods. Data gathered by a private firm under NPS contract demonstrated a tie between canal leakage and both the seeps near the Horse Quarry and the 1991 landslide scarp. Furthermore, the contractor found that approximately 5,000 acre-feet of water, or about 10% of the total canal flow, leaks into the subsurface each year (Anderson 1995).

In the course of drilling six new monitoring wells, we learned that one of the perched aquifers occurs in the open fractures of the basalt flow (Young 1994; personal correspondence). Water supplied by this perched aquifer is the cause of the 1991 landslide (fig. 2), a small slump and pond, and the wide zone of seepage and instability occurring around the Horse Quarry site.

Groundwater monitoring has identified a cyclic pattern to the groundwater flow in the Horse Quarry area. Combined read-

Continued on page 22

Table 1. Major Landslides

Year	Scarp Location	Attitude	Height m	Height (ft)	Displacement Volume m^3	Displacement Volume (yd^3)
1983	Bell Rapids	South	31	(100)	995,000	(1,300,000)
1987	Bell Rapids	East	62	(200)	918,000	(1,200,000)
1989	Bell Rapids	East	46	(150)	765,000	(1,000,000)
1991	Fossil Gulch	South	18	(60)	38,250	(50,000)
1993	Bell Rapids	East	no change		369	(482)
1994	Fossil Gulch	South	no change		84	(110)
1995	Bell Rapids	South	9-31	(30-100)	49,725	(65,000)
1995	Fossil Gulch	South	20	(65)	459	(600)
Total volume					2,766,387	(3,616,192)

Table 2. Contributions to the Landslide Assessment Effort

Organization	Contribution	Staff Experts
Idaho State University	Stratigraphy, lithology, & soil analyses	Geologists
Boise State University	Seismic refraction	Geophysicists
USGS Water Resources Division	Monitoring, drilling, logging	Hydrologists
USGS Earthquake & Landslide Branch	Soil strength testing, mapping, monitoring	Geologists
USGS Photogrammetric Laboratory	Landslide volume quantification	GIS technicians
Private consulting firm	Geoelectric assessment	Geophysicists
Bell Rapids Irrigation District	Trenching, pipe laying	Equipment operator
Idaho Power Company	Monitoring, mapping, assessing hazards	Geologists, GIS support, ecologists

ings from the two monitored seep locations below the Horse Quarry vary from 416-1,022 liters (110-270 gallons) per minute; the lowest readings were recorded from May to July and the highest readings were from October to December. The seepage increase in the fall coincides with elevated groundwater levels in the study wells that tap the basalt aquifer (Young 1995; personal correspondence). Water is piped into the canal from May to September for use during the summer growing season. The rise in the groundwater table, and increase in seepage discharge volumes, consistently mirror canal usage with a lag response time of around 5 months (Young 1983, 1984, 1985; personal correspondence).

The key factors in understanding why the Glenns Ferry Formation has a tendency to slide are slope gradient and the strength of the soils relative to their moisture content. Samples taken from landslide scarps and landslide-prone areas, have been classified as high plasticity clays and silts (Chleborad and Schester 1995; personal communication). With these types of materials, as soil moisture increases, and with slope gradients of 30 degrees and more, the ability of the beds to maintain their cohesiveness is slowly overcome, culminating in a landslide. This process is responsible for all of the landslides within the monument and is occurring most notably within 610 m (2,000 ft) of the Horse Quarry.

Solutions

Dewatering provides immediate relief to slopes under stress where this stress is the result of increased saturation. A seismic refraction survey of the Shoestring Road Basalt (fig. 2) helped us understand the probable subsurface pathways for groundwater migration in areas underlain by the basalt, by delineating the margins and general structure of the flow. This information allowed us to identify six drilling sites that appeared to offer the best probability of encountering groundwater. Of the six wells drilled, three contain enough water to allow dewatering. Initial results suggest that an amount equivalent to 20% of the groundwater currently being discharged at the seeps in the Horse Quarry area could be intercepted at these wells. However, not all of the water intercepted at these three well sites is being discharged at seep locations in the vicinity of the Horse Quarry, so the overall effectiveness of dewatering activity on the Horse Quarry area is approximately 14% of total discharge. Based on the limited number of dewatering locations, this effort is inadequate to stop the landslides. At best, it should reduce the frequency of failures and marginally improve the stability of affected areas.

Monitoring is essential in consistently and accurately tracking changes in slope behavior. Surface monitoring is critical for detecting movement in unstable areas for both visitor safety and research opportunity reasons. Subsurface monitoring is needed to track changes in groundwater levels, seepage discharge volumes, and soil moisture, all factors that contribute to landslide inception. While monitoring protocols implementation has begun, funding limitations have greatly slowed this process. By demonstrating the effectiveness of this monitoring program, we hope to encourage the financial participation of private parties in a joint, long-term monitoring effort.

The ultimate solution to the landslide problem involves keeping the groundwater away from the hillsides. Based on the geotechnical and hydrological data collected, a number of remedial methods are currently under consideration. Current plans call for the selection of a preferred alternative sometime later this year.

Gravity of the Problem

Landslides destroy the stratigraphic and depositional relations needed to interpret prehistoric ecosystems. Furthermore, in-place material is buried beneath

Figure 3 (left). The scarp below the Bell Rapids Canal demonstrates the severity of the landslide problem at Hagermann with two slides showing clearly. The 1987 slide is just out of view in this image, obscured by the bluff.

Figure 4 (below). In the vicinity of the 1995 slide, author Larry Growney leads a crew to rescue a peccary fossil in danger of being compromised by additional slides. Water still seeps out of the hillside near the Bell Rapids pump station although the canal on the bluff has been abandoned for years.

the landslide debris making it inaccessible and lost to study. The hazards that landslides present to researchers and visitors may result in area closures, further impeding research and resource enjoyment. To understand the true impact of a landslide, consider the following figures approximated for the 1991 landslide:

Volume of failed material
38,228 m^3 (50,000 yd^3)
Area buried by landslide debris
4,180 m^2 (5,000 yd^2)
Area of new scarp
1,338 m^2 (1,600 yd^2)
New restricted zone above scarp
836 m^2 (1,000 yd^2)

This example clearly shows that the total amount of land lost to paleontological exploration is much greater than just the volume of the landslide debris. Most park landslides occur at or very near the top of slopes. This means that the three-dimensional space (volume) lost to paleontological study can be much greater than the numbers from the above example suggest. Moreover, the soil strength of the debris pile is much less than that of the original hillside prior to the landslide. As a result, the debris piles are likely to remain unstable, creating a long-term threat to field research and exploration on and below these features.

Time and Preservation

We continue to inventory both long established and newly discovered fossil sites. Through the implementation of a monitoring protocol, which helps us set excavation and study priorities, many specimens have been recovered rather than lost to landslides. The combination of monitoring and fossil site inventory control gives us the ability to quickly identify threatened fossil sites, and respond before the scientific value of the resource is lost. However, even with these efforts, the landslides often beat us to the fossils. For example, a 3.2 million year old, still organic, log (see *Park Science* **14(1):7**) was covered by a small landslide before it could be adequately sampled for study.

By taking steps to inventory fossil sites, use hydrologic, lithologic, and geotechnical assessment techniques, and implement monitoring protocols, we have built the foundation for improving a very bad situation, and we are well on our way to developing an ultimate solution. However, until the source of the groundwater recharge is stopped, major landslides, and resource degradation, will continue to play a role in the development of Hagerman Fossil Beds National Monument. PS

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A social science tool for regional planning

Assessing Regional Economic Contributions from National Park System Units:

Figure 1. Manassas National Battlefield Park, with its popular stone house, was just one of 13 Virginia parks recently analyzed for its economic contributions to the regional economy. Park operations and visitor expenditures play a substantial role in local economies and can help leverage park preservation issues.

By Kevin L. Gericke and Jay Sullivan

Editor's note: *"A Handbook for Assessing the Economic Contributions of National Park Service Units" (Sullivan et al. 1993b–as listed in the literature citations at the end of this article) contains further explanation of information presented in this article.*

ACCORDING TO ITS MISsion, the National Park Service must make resource decisions seeking a balance between use and preservation. The tools of economics are useful in making these decisions, helping to justify investments, and allocating resources to national park system units. A simplified economic assessment tool known as the *money generation model* or MGM may be familiar to some readers as it has been circulated to parks to help managers and park neighbors gauge the economic impacts of the park on regional economies (see the companion article, "Why Assess The Economic Impacts of National Parks?, on page 26"). In a more detailed economic assessment of park contributions, three types of benefits occur: regional income and employment, resource values, and contributions to a community's sense of well-being. This article presents major issues to consider when conducting an economic assessment of park contributions and examples from a case study of national park system units in Virginia (Shenandoah National Park, Colonial National Historical Park, Manassas National Battlefield Park, etc.–see fig. 1) (Sullivan et al. 1993a).

Income and Employment Values

National Park Service operations often generate substantial income and employment in the surrounding region as a result of spending by visitors, the National Park Service itself, concessionaires, businesses, and other government agencies. The fundamental principle that guides the assessment of income and employment values is the *with and without* principle. That is, the analysis should identify only the income and employment effects that occur as a result of NPS operations in the region.

Two types of income and employment effects, direct and multiplier, must be considered. Direct income and employment effects are immediate economic activities generated by NPS operations. For example, direct effects include money spent by visitors to the park or jobs created in local restaurants to serve visitors. Multiplier effects are additional rounds of economic activity set in motion by direct effects. For example, to provide a meal to a visitor, local restaurants require groceries, energy for lighting and cooking, and many other purchases in the region. This purchasing activity can occur in many rounds, until the initial money has "leaked" out of the region through purchase of goods and services beyond the region.

A multiplier describes total economic activity in an area (direct + multiplier effects) in terms of business output, income, or employment in a region. The multiplier "expands" direct effects to the rest of the regional economy. Individuals often use the phrase "money turnover" to describe how many times a dollar changes hands in an economy before it leaves through payments made outside the region. This definition is not the same as a multiplier, however. For example, a multiplier is not *seven* just because a dollar changes hands seven times in an economy. With each transaction,

the regional economy loses a portion of the original dollar through payment of taxes, purchases of goods outside the region, and in many other ways. This leakage may cause the original dollar to dissipate quite rapidly in a region. Multipliers greater than 3.0 are unusual, and are not likely to be credible with outside groups.

Depending on the detail of analysis, a variety of information is needed about park visitors: number of visits, average daily visitor spending, average length of stay in the area, visitor origin, and destinations. Information is also needed about NPS spending (payroll and operating expenses), other government spending, state and local taxes and in-lieu-of tax payments, associated business investment, and multipliers. An analyst can obtain much of this information from monthly public use reports, state tourism boards, travel organizations, visitor services projects (CPSU-based social science programs that serves NPS social science needs) reports, state tax commissions, and universities.

Commonly Asked Questions

A common question about income and employment values is, "Do I include in my analysis those visitors who are residents of the region?" Income and employment effects often exclude spending by resident visitors. This approach is used because it is difficult to determine whether those visitors would have spent their money within the region if the park were not available (the with or without principle). Another question is, "Do I include the spending by visitors who stop at many attractions on their trip, with this unit being only one part of their trip?" It is only appropriate to consider the time and money spent in the vicinity of the park unit by these multiple-destination visitors. A third commonly asked question is, "Do I include concessionaire spending?" If the daily visitor spending estimates do not include purchases from concessionaires, then concessionaire spending is considered; otherwise, concessionaire spending is not considered, to avoid double-counting.

A study of the economic contributions of NPS operations in Virginia estimated that total contribution to business output in the state from national park system units was $474 million in 1993. Also, an estimated $117 million in personal income and 9,000 jobs in Virginia resulted from NPS operations. These results indicate a substantial contribution to regional economies as a result of NPS operations (Sullivan et al. 1993a).

Resource Values

A resource value is the amount individuals are willing to pay for the ability to enjoy the many goods and services that the National Park Service provides. While not as widely recognized as income and employment values, resource values are also significant contributions, because they may be more than what an individual pays as an admission fee or travel expense, thereby contributing to overall national wealth.

Resource values arise from the use and preservation of an area. The value from using an area may come from a consumptive activity (e.g., fishing), a nonconsumptive activity (e.g., learning about the history of an area), or an indirect activity (e.g., reminiscing with family who have visited park system units). The value for preserving an area may come from visitors knowing that they will have an option to see the resource in the future if they choose, or that the resource is a bequest for future generations.

The travel cost and contingent valuation methods are commonly used approaches for estimating resource values, and they require extensive visitor surveys. Economists have conducted hundreds of site-specific studies, resulting in a wide range of values for numerous activities (see Walsh et al. 1988 for a summary of studies). Other types of information are also indicative of the resource value individuals hold for units of the national park system, including membership in local conservation and historical societies, number of volunteer hours at a park, or the amount of public involvement in political and management decisions.

While it is difficult to conduct surveys for all parks in the national park system, an analyst can use previous studies to provide a first estimate of resource values. Information on visitation, travel costs, and visitor trip destinations are needed to calculate resource values. Park staff considering conducting an economic analysis may find local universities to be helpful in determining resource values.

Estimated resource values for units administered by the National Park Service in Virginia range from $2,000 to over $51,000,000 per year.

Estimated resource values for units administered by the National Park Service in Virginia range from $2,000 to over $51,000,000 per year. Other information collected also provides an indication of the value related to preservation of natural areas in Virginia: over 1,200 people are members of the Committee to Preserve Assateague Island; the Sierra Club serves over 12,000 Virginia members; and 1,200 people belong to the Virginia Native Plant Society (Sullivan et al. 1993a). With information of all

Continued on page 26

kinds about resource values, decision makers will be able to better understand why individuals desire certain management actions, provide for their needs, and maintain the integrity of the resource.

Community Values

The National Park Service also contributes to the sense of well-being in communities by providing ecological, cultural, and recreational services. For example, open space provided by national park system units may contribute to the quality of life in an area. In Roanoke, Virginia, commuters often use the Blue Ridge Parkway, despite the fact that it is a slower route than interstate highways. However, the parkway offers individuals a chance to unwind after a busy day at work.

Several methods can be used to assess community values, including personal interviews, monitoring media coverage, and examining written visitor comments. We interviewed local governments, chambers of commerce, and NPS personnel in the Virginia study. Respondents indicated how important the services provided by the parks were to them. These services included education programs, regional economic activity, cultural and historic preservation, natural environments preservation, social opportunities, and various recreational activities. The results indicate a range of perceptions about the importance of parks. For example, respondents from rural areas near national park system units tended to place a high level of importance on the effects to local business by the National Park Service. In urban areas, respondents placed a higher importance on the open spaces the units provide than the local business effects (Sullivan et al. 1993a). Assessing NPS contributions to community values is as important as resource values or income and employment values in fully understanding the relationship between the National Park Service and people in the surrounding region.

The National Park Service also contributes to the sense of well-being in communities by providing ecological, cultural, and recreational services.

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Why Assess T

By Ronald R. Switzer

For many years traditional park managers have done remarkably good jobs of protecting park resources and serving park visitors. Unfortunately, some stopped managing at park boundaries. That is to say, although they may have interacted with communities in their spheres of influence, too little time was dedicated to convincing those communities that the national park was an important neighbor, not just as a resource steward, but as a driving force in their local and regional economies. As such, the parks heavily influenced the quality of life over large areas, and needed to be recognized and brought to the table as equal players in long-range opportunity planning and economic development discussions, discussions that set the tone for compatible development, and that have the potential to reduce unwanted threats to the parks.

Many park managers grew their careers under the notion that those who visited national parks were just *visitors,* people who passed briefly through the resources and left no impact on the resources or the economy. In truth, the National Park Service has been in the tourism business since before it was officially designated in 1916, and what we do has dramatically affected local development and economics adjacent to all parks. Seldom have we taken stock of our contributions, and less frequently have we let our neighboring communities know the extent of those contributions.

While serving as tourism coordinator for the 13 national parks in Texas in a collateral duty capacity to the

CONOMIC IMPACTS OF NATIONAL PARKS?

Figure 1. Mammoth Cave National Park, Kentucky, is the single largest resource attraction in the state. Assessments of economic impact applied in positive ways can draw the national parks closer to the communities they serve.

position of Superintendent of Big Thicket National Preserve, the Texas superintendents began helping me assemble economic impact information on an annual basis. This information was made known to the local communities, and synthesized as educational information for the Texas Departments of Commerce and Transportation. The significance of the economic contributions of the parks became a catalyst for the formation of a federal-state tourism coordinating committee involving more than a dozen agencies. Eventually, this group split into the Federal Tourism Council and the State Tourism Council, both of whom signed a memorandum of agreement to participate as partners in the Texas strategic tourism plan and to work toward accomplishing mutual goals and objectives.

At the local level, Big Thicket National Preserve assumed the leadership of a potent group of federal and state agencies, local chambers of commerce, tourism bureaus, and businesses in the private sector, to further resource-sensitive tourism and outdoor recreation, economic development, and environmental education. This same approach is currently being pursued in Kentucky, and while it is too early to assess whether it will succeed, indications are positive. The current Kentucky tourism master plan calls for the formation of a federal tourism council, and one is in the making.

Assessments of economic impact applied in positive ways can draw the national parks closer to the communities they serve. While past and current assessments in Texas and Kentucky have been based largely on the NPS *Money Generation Model* (contact Ken Hornback of the Washington Office Socioeconomic Studies Division at (303) 969-6977), the results tend to be very conservative because they are based on low multipliers, and do not take full account of all economic factors. State generated models (and the one described in the preceding feature article) generally yield much higher impact figures, higher by 25-40%. Whatever model is used, the results are extremely important as barometers of the economic worth of the national parks locally, regionally, and even statewide. Because Mammoth Cave National Park is the single largest resource attraction in Kentucky (fig. 1), the impacts it generates are noticed at the highest levels of state government. When the impacts of the four Kentucky national park units are considered, our worth to the economic well-being of the commonwealth is fully appreciated.

We have made good use of the Money Generation Model, but you should be aware of some of its shortcomings. As already mentioned, the multipliers are applied very conservatively, probably under-estimating economic benefits by a considerable factor. Furthermore, the full impacts of concessioners are not taken into account because of the danger of counting visitor impacts twice in the same model. The calculations do not recognized that concessions operations contribute more than the capital improvement expenditures used in the formula for "other" expenditures when concessions operations *do* contribute more. Similarly, it fails to fully assess the impacts of employee expenditures for housing, health care, education, recreation, and living expenses locally. In addition, most models do not take into consideration the contributions of the National Park Service in funding and grants for urban park and recreation projects executed under statewide plans.

If the Money Generation Model does not fulfill your needs, I encourage you to work with your nearest cooperative park study unit, university department of park or outdoor recreation planning, or state department of travel development to develop one that measures critical economic impact. This helps assure that the information becomes a visible and appreciated part of growing partnerships with your local constituencies. Trust me, this works. PS

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Pseudoreplication Issues versus Hypothesis Testing and Field Study Designs

Alternative study designs and statistical analyses help prevent data misinterpretation

By Roy Irwin and Lynette Stevens

Editor's note: *Pseudoreplication issues are complex, and space constraints allow only an introduction here. A more detailed recap and a related summary of impacts considered* de minimis[1] *(small enough to be trivial) is available through e-mail from Roy Irwin, "roy_irwin@nps.gov".*

Pseudoreplication has become a popular buzzword that has attracted considerable interest, controversy, and confusion. The debates over pseudoreplication began with Hurlbert's introduction and definition of the term pseudoreplication as:

> *The use of inferential statistics to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates are not statistically independent (Hurlbert 1984).*

Since 1984, many papers have attempted to refute, better explain, and expand on the issue of pseudoreplication. Pseudoreplication occurs when classical hypothesis-testing treatments are not technically replicated or statistically independent. Pseudoreplication often involves (but is not limited to) situations where investigators extrapolate site-specific statistical inferences beyond the situation that was studied. Pseudoreplication does not describe just a particular type of experimental design, but rather a particular category of misinterpretations or incorrect analyses.

Although many NPS studies involve routine inventory and monitoring rather than experiments to document effects of various stresses, staff doing inventory and monitoring studies should be aware of pseudoreplication issues. In many cases, others will eventually compare past and present data in an attempt to get insight as to whether or not a trend is developing or whether or not some impact (a treatment) is causing resource deterioration. Therefore, inventory and monitoring studies should be designed to maximize their utility for future trend or injury analyses.

Pseudoreplication does not describe just a particular type of experimental design, but rather a particular category of misinterpretations or incorrect analyses

Example

A common example of pseudoreplication occurs when repeated observations of a subject are substituted for replicated applications of a treatment on different subjects. In this situation, the sample design calls for taking measurements over time, but uses only one control and one treated site (subject); data are not spatially replicated. For example, consider a common before-and-after study to determine effects on aquatic biota from some point source effluent entering a stream (e.g., a power plant on a river). The study design consists of two sample points: one above the input and one below. Although several samples may be collected above, and several below, these are not true "replicates" for purposes of hypothesis testing coupled with inductive (from specific case to general case) inference, since there is only one treatment (the power plant effluent) and one experimental unit (the specific river). Due to lack of true replication, inductive statistics should not be applied. In other words, you cannot use the results of this study to generalize about any other power plants or other stream systems, or even to conclude that the power plant caused the difference seen in this one situation.

A key point to keep in mind is that Hurlbert's original definition concerned pseudoreplication with respect to testing effects of treatments. By common (mis)usage, some have also used the term pseudoreplication more broadly to include such things as no replication or inappropriate replication, even in the absence of an effort to examine treatment effects (cause and effects) through the use of inductive statistical inferences. Examples would include the following: (1) taking three sediment samples from one area, thoroughly mixing the three in a pan, putting portions of the mixed sample in three separate jars, and then calling the three jars three "replicate" samples; or (2) taking three samples so close together in time or space that they are really more like one sample than three samples.

In routine monitoring, these examples of questionable replication, in the absence of treatment effects testing, may be considered unwise or inappropriate, but would not be considered pseudoreplication under Hurlbert's original definition. Although often done, criticizing a data set as "pseudoreplicated" is usually inappropriate unless statistical inferences are made for cause and effect.

[1] The phrase *de minimis* is an abbreviated form of the Latin phrase "de minimis non curat lex," which translates to "the law cares not for small matters;" in risk assessment, de minimis impacts are those that are so small (and not related to special resources such as endangered species) that one can disregard them.

Pseudoreplication Issues in Ecology

Due in part to large amounts of natural variance, lack of baseline ecological data, and lack of adequate funds for complete replication of studies (or treatments), occurrence of pseudoreplication is especially high in ecological research. Pseudoreplication is not inevitable if an experiment lacks treatment replications, but occurs only if the researcher misleads the reader by applying inappropriate statistical analyses or misstating the strength of the evidence obtained (Hargrove and Pickering 1992).

ield situations are often uncontrolled, unreplicated, and ypified by so many confounding variables that cause and ffect is difficult to establish.

However, lack of true replication should not be portrayed as an evil to be avoided in all situations. Often pseudoreplicated (or unreplicated) studies cannot be avoided in disciplines such as medicine, regional ecology, observational field ecology, and astronomy, but the state of "scientific" knowledge or site-specific or issue-specific understanding of issues still slowly progresses to new heights, mostly through weight-of-evidence approaches. Just as astronomers cannot directly manipulate stars, and therefore are prone to pseudoreplication, regional ecology research is difficult or often impossible without pseudoreplication (Hargrove and Pickering 1992). While population studies of animals with large home ranges may not be appropriate for experimentation, sample surveys and demographic studies may still be used to assess population effects (Skalski and Robson 1992).

The following are red flags for potential pseudoreplication problems (Meyer et al 1994):

Red flag #1–Use of more than one data point from given random or systematic plots or locations. **Solution**–Use one datum per sampling unit in statistical procedures. **Illustration**–If you measured the length of 97 plants in a quadrate, report one number, (the average or median, for example). Avoid the temptation to say N=97; instead, say N=1.

Notes: Many contaminants and biology effects data sets are not normally distributed, so it is often preferable to use nonparametric methods, to dispense with means and variances altogether, and to utilize alternative descriptive measures of central value and variability for skewed data, such as the median and interquartile ranges–IQR (Heisel 1990). In epidemiology work, a common practice is to compare only three groups: those with clearly high doses, those with clearly low (or no) doses, and an intermediate group. Even random selection of study sites from assessment and reference areas is "subsampling" or pseudoreplication if statistical conclusions are extrapolated beyond the assessment and reference areas (Meyer et al 1994).

Red flag #2–Use of the same plots or locations over time (OK for determining what happens to that one plot but not for larger universes).

Red flag #3–Multiple observations on same animal (OK for determining what happens to that one animal but not for determining what happens to populations).

Red flag #4–Measurements on the effects of a single point source on a river, up- and downstream. Limiting the statistical inference to that unique location above and below is not pseudoreplication. **Note:** It is safest not to expand your inferences beyond that one site and situation and not to pretend that your significant levels or various statistical inferences prove the cause of any differences noted.

Statistics Applied to the Scientific Method and Risk Assessment

The ideal way to build scientific knowledge is to use the scientific method in true experiments. A typically recommended scenario would be to combine genuine replication with random assignment of treatments to experimental units or probabilistic sampling from a study area (personal communication, Lyman L. Mcdonald, West Inc., 1995). However, while genuine replication is a powerful tool that should be used when possible, the scale of ecological research should not be dictated by statistical constraints (Hargrove and Pickering 1992).

In the absence of truly random samples, convincing evidence of an effect requires the effect to be demonstrated consistently at different times in different places (Meyer et al 1994). Consistent effects of incidents comprise a non-statistical type of inference. Such inferences are deductive (general case to specific case) or nonstatistical (Meyer et al. 1994). Although difficulty in replicating large-scale field manipulations makes quantifying

The problem is often triggered when the investigator uses a classical null hypothesis testing analysis and overstates conclusions related to the causes of the differences

Continued on page 30

cause and effect relationships difficult, this loss of statistical inference to pseudoreplication may be offset by carefully developing ecological inferences (Hargrove and Pickering 1992).

Pseudoreplication can be avoided by applying truly replicated treatments or by restricting the generality and comprehensiveness of one's conclusions.

Ecological (deductive, weight-of-evidence) but not statistical (inductive) inferences can be made even when treatments are not replicated (personal communication, Lyman L. Mcdonald, West Inc., 1995). For example, normic statements (i.e., statements of what usually or normally happens that are generated by the collective outcomes of repeated experiments) can be the result of pseudoreplicated experiments. Although these statements are not universal, probability based, or predictive, they represent generalizations with exceptions. Even so, the information content of normic statements is high in terms of explanatory power (Hargrove and Pickering 1992).

Some of the problems related to pseudoreplication in field studies arise because the investigator is conducting an observational study rather than a manipulative experiment. The problem is often triggered when the investigator then uses a classical null hypothesis[2] testing analysis and overstates conclusions related to the causes of the differences. This has become common partly because most standard textbooks dealing with statistics and biological study design do not adequately distinguish between statistical conclusions drawn from manipulative experiments and statistical conclusions drawn from observational studies (Meyer et al 1994). The arithmetic analysis is often the same for both types of design, but the statistical conclusions of a manipulative experiment extend to the protocol by which the study was conducted while the statistical conclusions of an observational study are limited to the specific assessment area, reference area(s), baseline conditions, and assessment period in the study (Meyer et al 1994).

Hypothesis Testing and Pseudoreplication

Pseudoreplication problems are often partly the result of inappropriately trying to force non-replicated data into classical null hypothesis testing molds. Descriptive statistics, predictive methods, or various other observational data analysis methods are often more appropriate than classical null hypothesis testing schemes for environmental observational studies, injury assessments, many before-and-after (BACI) applications, upstream-downstream studies, and ecological risk assessments.

At least some hypothesis testing assumptions are typically violated in field studies. A thorough discussion of the pitfalls of using hypothesis testing in field study applications would require a separate article, but the following notes from Suter regarding hypothesis testing versus risk assessment and field studies are helpful in understanding pseudoreplication issues. The following points were presented briefly in Suter's Ecological Risk Assessment Text book (Suter 1993) and expanded in a platform session paper presented at the National SETAC meeting in Denver, November 3, 1994: entitled "The abuse of hypothesis testing statistics in ecological risk assessment." A paper of the same title and basic content was in press as of January 1996, in *Human and Ecological Risk Assessment.* A synopsis of the information is presented here with permission of Glenn Suter):

"In ecological epidemiology there is no random assignment of populations or communities to treatments and treatments are almost never replicated so we cannot use statistics to test the hypothesis that populations or communities treated with a pollutant are different than those that are not.

There is no truly random assignment of treatments. The investigator cannot randomly assign some reaches to be treated with an effluent and others not to be treated. In other words, while hypothesis testing requires random assignment of treatments, the investigator has typically had no role in where the effluent pipe was placed.

In field studies there is often only one treatment (an effluent, for example) rather than replicated treatments. Multiple biological samples (for example, benthic macroinvertebrates) are often taken above and below the effluent. However, the downstream samples are taken from one community affected by a single effluent and the samples are pseudoreplicates from that one treatment. In other words, samples from above and below a discharge pipe are not true replicates, they are pseudoreplicates since there is only one treatment.

The question often arises: can't we use hypothesis testing if we do it right? There have been heroic efforts to do so (for example, the Stewart-Oaten, BACI design which nevertheless does not totally solve the problem).

Since there is an inherent bias in favor of the null hypothesis, hypothesis testing places disproportionate burdens on environmental protection. Those who would protect the environment are required to prove with 95% confidence that effects are occurring. This bias is defensible in pure science but indefensible in risk assessment; it rewards polluters who perform poor studies with few replicates and high variances due to sloppy techniques. Hypothesis testing provides less protection for organisms less abundant or more difficult to sample.

[2] The null hypothesis is the hypothesis that an observed difference (as between the means of two samples) is due to chance alone and not due to a systematic cause.

Polluters love hypothesis testing since it can be done with poor data.... They can then fail to reject the null hypothesis and the environment is not cleaned up.... Our real problem is often defining real significance.... Often we should use descriptive rather than experimental statistics."

Some Solutions

Two study sites in a single area, for example, just up- and downstream of a discharge, can properly be sampled and compared using descriptive statistics relating to magnitudes, variances, and trends. Some would say they could also be compared using a classical null hypothesis testing scheme, while others would say a null hypothesis testing scheme should not be used. Both would agree that no matter which statistical methods are used, if a difference is shown, the investigator only knows that they are "different," has not proved why they are different, and should be careful not to generalize the results to other sites, times, or conditions that were not studied. Although field researchers have sometimes determined that the samples are "different" using hypothesis testing, conclusions as to why they are different often cannot be drawn (Suter 1993).

Some experts say the results (that the samples are different) of hypothesis testing at one site could be used as one of several clues making up a weight-of-evidence argument related to effects at that one site. Other experts would argue that it is better to use descriptive statistics to suggest that the samples are "different" and thereby avoid any hint of an incorrect conclusion that cause and effect has been "proved" at any given significance level.

A key point to keep in mind is the importance of properly limiting inductive inferences or conclusions. Pseudoreplication can be avoided by applying truly replicated treatments or by restricting the generality of one's conclusions (i.e., not overstating results) (Dixon and Garrett 1994). Some would argue that restricting the generality of one's conclusions might sometimes involve stating that you do not know why the samples are different.

Instead of hypothesis testing, using descriptive statistics and a weight-of-evidence approach to link potential relationships is often better (Suter 1993). Field situations are often uncontrolled, unreplicated, and typified by so many confounding variables that cause and effect is difficult to establish. The weight-of-evidence approach (which often includes statistical data from both field and lab sources) is often safer in ecological, risk-injury assessment, and contaminants field work (Suter 1993, Chapman 1995).

It is sometimes acceptable to set up the analysis in terms of tests of bioequivalence in the following manner: Assume the treatments will result in a difference in bioequivalence, including variation up to de minimis amounts of acceptable natural variation. The investigator determines the level at which there can be a change without exceeding bioequivalence thresholds (for example, a percentage change in an endpoint such as biomass or number of taxa). If the effect does not exceed a certain percentage previously chosen by the investigator as a trivial or de minimis change, the change has not exceeded a bioequivalence threshold. Such an approach requires the investigator to deal with issues of natural variation and confidence.

Conclusions

Understanding the intricacies of pseudoreplication and hypothesis testing versus field study design issues is not an easy task. The importance of proper determinations of the interrelationship between study objectives, study designs, data analyses, and statistical inferences in field investigations cannot be stressed enough (Skalski and Robson 1992). Those lacking expertise in statistics, may find it wise to first consult a statistician familiar with pseudoreplication and the study design issues discussed herein (not just any handy statistician or book). It is also wise to develop a written (and defendable) statistical design plan prior to beginning the study.

PS

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Meetings of Interest

JULY 7-10 To be held in Keystone, Colorado, the 51st Annual Conference of the Soil and Water Conservation Society will address conservation and ecosystem science, ecological decision making and management, and sustaining ecosystems. For more information, call 1-800-THE-SOIL.

AUGUST 11-15 The Ecological Society of America will hold its annual conference in Providence, Rhode Island. The National Park Service will host a panel discussion on its natural process wildlife management policy. For more information, contact the society at 2010 Massachusetts Avenue, NW, Suite 400, Washington, DC 20036; e-mail: "brian@esa.org".

AUGUST 19-22 The 15th annual North American Resource Modeling Conference, Evolutionary Consequences of Resource Management, will take place in Lutsen, Minnesota. Sessions will address the potential for evolutionary biotic and ecosystem change as a result of global human impacts. The conference will bridge the gap between theoretical ecology, evolutionary ecology, and natural resource management (including the idea of sustainable yield) in examining issues that involve natural resource modeling. Contact Julie Karels of the Department of Fisheries and Wildlife, 200 Hodson Hall, University of Minnesota, St. Paul, MN 55108.

SEPTEMBER 9-20 Front Royal, Virginia, will be the venue for the technical conference, Biodiversity Monitoring at Permanent Plots. Contact the Smithsonian Institution/MAB Program, 1100 Jefferson Drive, SW, Suite 3123, Washington, DC 20560; fax (202) 786-2557, for more information.

SEPTEMBER 14-19 Florence, Italy, will play host to the 17th International Meeting for specialists in air pollution effects on forest ecosystems. Entitled, Stress Factors and Air Pollution, the gathering will focus on recently discovered effects of air pollutants on forest ecosystems, with special reference to the interactions between environmental stress factors. Sessions include: interactions between air pollutants and abiotic and biotic stress factors; impacts on wildlife and ecology; air pollution and global change; and biodiversity conservation. For more information, contact Dr. E. Paoletti; C.S. Patologia Specie Legnose Montane; CNR, Piazzale delle Cascine 28; I-50144 Firenze; Italy; phone 39-55-368918; e-mail: "raddi@cspslm.fi.cnr.it".

OCTOBER 19-21 The American Society of Landscape Architects will hold its annual meeting in Los Angeles. This exposition will focus on compelling evidence of landscape architecture work in planning, design, and technology that contributes to societal well-being. Contact Cheryl Wagner (Fax: 202-686-1001; e-mail: "cwagner@asla.org") for more information.

OCTOBER 25 Bandelier National Monument, Santa Fe National Forest, and the Los Alamos National Laboratory are co-hosting a no-fee Symposium of Biological Research in the Jemez Mountains, New Mexico, in Santa Fe. Contact Stephen Fettig ("stephen_fettig@nps.gov"; 505-672-3861, ext. 546), NPS Wildlife Biologist at Bandelier, by July 1 if you are interested in making a presentation; abstracts are due September 15.

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PARK SCIENCE
Integrating Research and Resource Management

Volume 16 – Number 3 National Park Service • U.S. Department of the Interior Summer 1996

The Natural Resource Trainee Program: Professionalization Triumph of the 1980s and Early 1990s

Who are they and where are they now? *See the key on page 17 to identify these participants of the first Natural Resource Trainee Program and learn what they are up to now.*

By the editor

The need to establish and professionalize science and resource management functions and apply them in the management of national parks was recognized as early as the 1930s. Then, biologist George Wright published several papers on wildlife management and made the clear connection between science and informed park resource management activities. Yet, for the next 5 decades, resource management work continued to be done mostly by park rangers who were trained primarily in law enforcement and other operational areas, not necessarily in an applied science. In 1976, Bandelier National Monument Park Ranger John Lissoway, involved in park visitor protection training at the time, recognized the lack of a natural resource component to round out his training. Southwest Regional Chief of Resource Management Ro Wauer suggested a resource management training component be added.

Working within the scope of the IDP (Individual Development Plan) program–a NPS training needs and personnel development tool–Lissoway and Bandelier Superintendent John Hunter identified park resource management needs and translated them into concrete training requests. Each training need was product oriented, bringing direct benefit to the park. To achieve Lissoway's natural resource training goals, they identified training advisors–often from other agencies, the private sector, or universities–who would be the primary sources for imparting the skills. Regional office funding allowed parks to send staff to the training and backfill behind them to take care of unfinished park work. Other superintendents soon heard about the training opportunity and wanted to be a part of it. Wauer then prioritized individual park needs, opting for placing resource management trainees at parks that formerly didn't have any resource management expertise.

The program went national in the early 1980s following publication of two different conservation organization reports on threats to national parks and a response by the National Park Service in the form of a state-of-the-parks report. Having a surprisingly deep impact, the latter report prompted Congress to direct the National Park Service to identify potential remedies to the threats it so capably identified. One of those remedies was to train staff in professional resource management techniques and get them out to the parks with the greatest needs. Called the Natural Resource Trainee Program, the initiative was patterned after the pilot training efforts developed in the Southwest Region. Having moved to the Washington office, Wauer became the primary coordinator for the new course along with the help of Southwest Regional Chief Scientist Milford Fletcher. Seeking to place 30 trained resource managers in high priority parks each time the course was offered, the first 2-year class began with 36 trainees in August, 1982 (see the key to the cover photograph and Table 1 on page 17).

Continued on page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 16—No. 3 • Summer 1996

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations–materials do not undergo refereed peer review. The bulletin is published in January, April, July, and October for distribution to interested parties. Visit *Park Science* on the World Wide Web at *http://www.aqd.nps.gov/nrid/parksci.*

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to the National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. See current submission guidelines on page 5. Contact the editor at:

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Printed on recycled paper

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DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

This fall, we will take a look at the status of resource management for lepidoptera (moths and butterflies) in northeastern parks; a process to assess the condition of riparian and wetland areas; results from the Park Science reader survey; accounts of new paleontological finds in two parks; a new process for evaluating park construction proposals that benefit natural resource preservation; property rights to genetic resources; and a review of the book, Wildlife Policies in the U.S. National Parks.

On Being Prepared

As you may know, President Clinton recently announced a land swap between Canadian-held Crown Butte Mines, Inc., and the federal government, effectively killing the proposed New World Mine near Yellowstone. Had it gone through, this project would have developed an underground mining process to recover gold, silver, and copper from a mountain near the park's northeast boundary. The controversial project had the potential for long-term contamination of Soda Butte Creek in Yellowstone and also endangered the Clark's Fork of the Yellowstone River, a federal wild and scenic river.

The high-level deal did not come by politics alone and it did not come overnight. It was based on a steady stream of technical information and reasoned analysis that has been flowing from scientists and resource managers to park administrators and political representatives for several years. Certainly, the proposed mine was also an emotional issue, but geologists, biologists, hydrologists, and water resource specialists played the central role in making the scientifically based case against the project. They even suggested the land swap.

Not all threats facing parks are as prominent as this, yet the process to deal with them involves the application of information gained through research. This relationship, the core of this publication, is illustrated throughout this issue in articles that span the continuum from documenting park resources to resource manipulation.

We cannot possibly predict all threats to the natural resources in our care, but we can prepare for some as Toben Lafrancois points out in his article on the diverse aquatic life in rock pools at Capitol Reef National Park. A part of his study involved a resource inventory process, a fundamental building block for resource preservation that is the basis from which so many other resource activities are based. We also need to be prepared to examine our work critically from time to time and make midcourse corrections. Laurel Last and Richard Whitman share suggestions on this subject in their examination of the water quality monitoring program at Sleeping Bear Dunes National Lakeshore. Demonstrating the possibility of a strong marriage between science and interpretation, Jeff Marion and Susan Brame bring us up to date on the *Leave No Trace* backcountry ethics education program that is having success in minimizing impacts to wilderness.

If, as Louis Pasteur suggested, chance favors only the prepared mind, then nowhere is preparation more important than in our own workforce. As the lead article details, the Natural Resource Trainee Program was a successful investment in the future of NPS natural resource management. As a result of that course and a similar one just begun, we are continually preparing to handle future unknowns like the New World Mine.

Jeff

Director Kennedy Honors Natural Resource Stewards

National Park Service Director Roger Kennedy recently announced the 1996 winners of the prestigious Director's Award for Natural Resource Management. Given annually, the awards recognize and foster outstanding contributions to natural resource management and research. The honorees include a NPS park superintendent, a NPS resource manager, and a federal government scientist whose work supports park natural resource preservation. The awards were presented at a ceremony in San Francisco in August. All winners received a plaque and a $2,500 monetary award.

Superintendent of the Year for Natural Resource Stewardship

Bryan Harry, Superintendent of the Pacific Island System Support Office, is the recipient of this award, which recognizes innovative resource management and support by a NPS superintendent. An outstanding leader, Bryan has demonstrated an ability to protect and restore native ecosystems in Hawaii and the Pacific islands during the last 25 years. His influence has resulted in realistic prospects for conserving highly significant vestiges of native Pacific ecosystems. As Superintendent of Hawaii Volcanoes National Park from 1970-1974, he and his staff changed the mindset in Hawaiian parks from accepting "inevitable" resource deterioration to proactive management that reverses deterioration and restores biological diversity. Upon returning to the islands as Pacific Area Director from 1982 to the present, Bryan presided during an era of tremendous progress in coping with resource issues in Hawaiian parks and expanded proactive management to parks throughout the Pacific.

"I am happy to accept this award," Harry stated, "because it recognizes the accomplishments of park crews and resource managers working with the cooperative park studies unit (CPSU) to mitigate the impacts of nonnative species in the Pacific Island parks. The 'mindset' we changed was to integrate the work of resource managers, park crews, and the scientists at the CPSU. We also shifted our concept of measuring success from how many alien animals we killed to basing removal decisions and efforts on the overall impacts the nonnative species have on the native populations. We have had some success, particularly with large mammals, but have lost the avifauna on Guam to a tree snake. Another difficult area is fire-adapted nonnative grasses." Harry continued, "Hawaii may be providing the national park system with a taste of things to come. While island ecosystems are the first to feel the severity of effects of nonnative species, I think the mainland will face the same challenges in the future; the mainland is just a bigger island."

Natural Resource Manager of the Year

Terry Hofstra was chosen for his contributions in guiding the Redwood National and State Parks resource management staff as they forged important working relationships between neighbors, parks, and private entities. A leading proponent

Continued on page 4

and facilitator of interagency and intra-agency and private sector cooperation, Terry has helped the parks advance toward ecosystem management. Using this approach, the parks have been able to address a broader range of issues over the past 6 years. Pleased to be recognized, Hofstra pointed out that "an award like this is an indication that the entire staff is effective in working toward park preservation goals."

One of the largest resource management operations in the national park system, this staff of more than 40 have concentrated on restoration activities, including mitigating erosion, as a result of logging. While 170 miles of logging roads within the park have been restored under his leadership, an additional 3,000 miles of roads within the watershed have the potential to cause severe erosion and damage to park resources downstream. Hofstra's staff, including archeologists, fish and wildlife biologists, botanists, ecologists, geologists, hydrologists, fire specialists, and maintenance and administrative personnel, have slowly begun to garner the trust and interest of the neighboring private landholders and have started to inventory the condition of the roads in the watershed. A measure of their progress is that the park is now routinely invited to review logging plans *before* they are filed and is able to address park concerns before logging or other activities on adjacent private lands begin. To aid in communication between the partner parks, Hofstra has also helped arrange for a full-time state parks resource manager to be integrated into the operation.

Hofstra has also applied the principles of managing the complete range of resources into a cohesive, large-scale program that includes wildlife management and planning. Redwood National and State Parks are home to the endangered Marbled Murrelet, an ocean-feeding bird that nests atop old-growth trees. When an adjacent landowner recently petitioned the U.S. Fish and Wildlife Service for a permit to log the remaining 564 acres of old-growth redwood from its property, Hofstra, ironically, foresaw the potential for long-term benefit to the murrelets within the park. By preparing a second-growth forest management plan in the interim, the parks are now poised to accept funds, mandated by the Endangered Species Act, to counter habitat disruption from the logging company. If its request for a permit is approved, the firm would pay for thinning 10 acres of second-growth forest within the parks for every acre disturbed on private land. Thinning a second-growth forest increases the speed by which the woods return to old-growth, providing increased future habitat for murrelets. If this comes to pass, Hofstra sees it as "a timely and much needed example of the flexibility of the Endangered Species Act in providing for endangered species preservation while accommodating some commercial activities."

Research

This award is given to the federal employee who has made the most significant scientific contribution to the NPS natural resource program through the development of creative research projects, published research, or the initiation of science programs. Dr. Paul A. Buckley, Senior Scientist (Ecology) with the National Biological Service Cooperative Park Studies Unit at the University of Rhode Island, was recognized for research and natural resource preservation accomplishments that have greatly assisted the National Park Service in achieving its preservation goals. His personal research program, leadership in many areas of natural resource preservation, and influence on national preservation policy span nearly 25 years in association with the National Park Service.

"Winning this award is extremely satisfying, because my colleagues and I have been very persistent over the years pursuing what we knew were critically needed park research projects," Buckley commented. "Nearly all of my own research," he continued, "has been management driven. I have been entranced, captivated by great personal satisfaction from the successful application of research results to park management."

Buckley enjoys tackling some of the most vexing research questions today–those that involve looking at the interplay between various resource recreation uses and their impacts on the population numbers and health of plants and animals. His expertise in this regard is population biology of shorebirds and the biodiversity of birds throughout the northeastern national parks. His work typically results in providing information to managers who must make difficult decisions about resource protection and visitor use.

Working as a shorebird ecologist in the late 1970s, Buckley assisted the National Park Service in gaining colonial waterbird and Piping Plover habitat protection in the face of numerous beach nourishment projects proposed by the U.S. Army Corps of Engineers along Fire Island National Seashore, New York. In addition, Dr. Buckley is still involved with investigations he initiated in the 1980s concerning the interrelationships among waterbirds, including Laughing Gulls in the Jamaica Bay Wildlife Refuge Unit of Gateway National Recreation Area, and aircraft on the adjacent John F. Kennedy International Airport. Buckley also began funding and doing some of the first work on the ecology and management of Piping Plovers, an endangered eastern U.S. bird species that, thanks in large measure to NPS management in coastal parks and seashores, is now making a comeback. He is quick to warn, however, that "if we make poor decisions [regarding uses of plover nesting beaches], recovery could be set back in a hurry."

While Dr. Buckley acknowledges the importance of applied research in meeting park management needs, he also observes that "there is tremendous need for much more site-specific inventory and general ecosystem research in our parks. Such research might not have obvious immediate application, but is nonetheless essential to the long-term management of the natural resources under our care."

Moving away somewhat from the kinds of projects he has worked on over the last 25 years, Buckley is currently involved in a massive, 5-year, multi-investigator study at Fire Island quantifying, for the first time, the relative roles of migratory and resident birds, deer, small mammals, and ticks, in the ecology of Lyme disease. Here, too, he has succeeded in maintaining that elusive, but critical mixture of research that is at once the most basic, and yet still the most applied.

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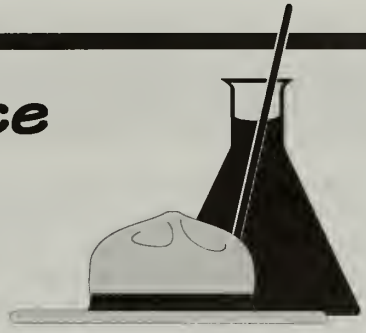
Writing for Park Science



Publication Overview

What is Park Science?

Park Science is a quarterly, 32-page, research and resource management bulletin of the National Park Service of the U.S. Department of the Interior. The publication strives to strengthen the links between research and park management. Articles describe both experiments that relate to resource conservation and the application of science in resource management practices. Technical in nature, *Park Science* is edited for the educated lay reader. It is published four times per year (April, July, October, and January) and is also available on the Internet World Wide Web at *http://www.aqd.nps.gov/nrid/parksci.*

What Kinds of Articles are Published in Park Science?

Park Science articles are popularized, field-oriented accounts of general interest research and resource management topics. Articles consist of case studies (specific park-applied research and resource management project write-ups), feature stories (personalized reports on research and its application or professional growth experiences), and short stories (brief articles of broad interest and applicability). Repeating columns include editorials (relevant opinions about current trends in research and resource management), Information Crossfile (synopses of longer, often scholarly works relevant to resource managers), Meetings of Interest (a calendar of important upcoming conferences), Notes from Abroad (accounts of international resource management and research experiences), Man and Biosphere Notes (a report on the MAB program of UNESCO), book reviews and profiles of new publications, 15 Years Ago in *Park Science* (a look back at an earlier story), and Highlights from around the national park system.

Questions

The following guidelines should clarify most of the submission criteria for case studies, feature-length articles, and cluster highlights. However, please contact the editor if you would like to discuss these guidelines in more detail or if you would like help in developing a specific story.

Case Study and Feature Article Submission Guidelines

Focus and Tone

Case studies and feature articles should emphasize the implications of natural or social science research for the management of natural, cultural, and human resources. A broad readership calls for clear communication–highlight main concepts, explain project significance and methods, and detail applicability to management. Write primarily in the active voice and explain technical terms.

Target Audience and Primary Authors

Principal readers and contributors comprise national park system area superintendents, resource managers, natural and social science researchers, interpreters, maintenance staff, visitor and resource protection rangers, and other technical and nontechnical personnel. Circulation also includes other federal agencies; state departments of fish and game, parks and recreation, and natural resources; international parks; private conservation organizations; the academic community; and interested public.

Criteria

Feature articles and case studies may include (1) a description of the resource management problem(s) that prompted the research; (2) an explanation of the significance of the resource management project; (3) discussion of management considerations related to the problem(s), such as relevant legislation (enabling, NEPA, ARPA, Endangered Species Act, etc.), pertinent park planning documents (GMP, SFM, FMP, RMP, etc.), planning procedures, and political considerations; (4) a summary of the methodology of the experiment; (5) the results and ramifications of resource management implementation options; (6) a description of how the findings were applied in the field; and (7) an appraisal of the scope of applicability of the findings to other park areas. As additional information about a project accrues, follow-up reports (one or more years later) may be very useful in fine tuning conclusions.

Length

Flexible, but aim for 1,500 words.

Author Information

In addition to a byline, include position title, park area or affiliation, a brief biography, work address, phone and fax numbers, and e-mail address.

Measurements

Report measurements in metric (using abbreviations for units) followed by English in parentheses. Time is to be reported using A.M. and P.M.

Deadlines

Fall issue–August 1; Winter–November 1; Spring–February 1; Summer–May 1.

Illustrations

Submit several illustrations. Show personnel at work, project equipment, techniques used, locator maps, species portraits, etc., to illustrate the major points of the article. Color slides (35mm) are best, but original line art, photostats, high quality photocopies, black and white photographic prints (glossies preferred), and color prints are also acceptable. Computer-generated illustrations (i.e., scanned art, ArcView maps, etc.) can be forwarded through cc:Mail, on floppy disc, or on laser-printer originals

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Guidelines revised August 21, 1996

(600 dpi if possible). Include the name of the artist or photographer and documentation of approved use if the illustration is copyright-protected. Label each illustration with park name, article title, any placement information (e.g., fig. 1), and the file format (e.g., TIF, EPS, etc.).

Captions

Include a description for each illustration that describes the relationship of the illustration to the theme of the article.

Delivery

Send contributions to the editor using these methods in priority order:

(1) by cc:Mail with the word-processed document and any illustration files attached. Indicate the word-processing software and version in the cover message (e.g., WordPerfect 5.1);

(2) over the Internet. First save the word-processed document as a text file (i.e., *.TXT);

(3) by fax. Use double-spaced, laser-printed originals if possible. Illustrations may not be faxed.

(4) by mailing the hard copy (double-spaced) and a floppy disc containing the word-processed document (indicate the software and version) and any illustrations;

(5) by mailing the double-spaced hard copy (laser-printed originals if possible) and any illustrations alone;

Review Procedures

Prior to submission to the editor, submit courtesy copies to both the area manager (superintendent) for policy considerations and the appropriate associate field director for natural resource stewardship and science. The editor and editorial board review articles for general appeal, relevance, usefulness, technical credibility, solution-oriented discussion, and agreement with submission criteria. Following editorial review, the editor will contact the author to discuss revisions and finalize the article.

Contributing to the *Park Science* Highlights Column

Content

The Highlights department presents an overview of the diversity and complexity of research and resource management work undertaken by the National Park Service on a cluster by cluster basis. An entry may, for example, summarize a research or resource management project; detail a noteworthy accomplishment; relate a new development, technique, or trend; discuss a challenge or complication; describe project implementation under a national resource management initiative; or profile a principal investigator. Ideally, these synopses focus on work conducted at parks rather than at the system support office in support of parks. In many cases, highlights items would make terrific feature articles, but are presented in brief as a snapshot of the research and resource management work being accomplished cluster by cluster.

Focus and Tone

Submissions should be written in lay language in the active voice. Include names of personnel and the areas featured in each entry. Strive to briefly answer the who, what, why, when, where, and how questions about the story. Stress the relationship of the subject to either a resource management or planning problem or to the state of the art of the discipline being discussed.

Length and Number of Entries

Entries vary greatly in length from 50 to 350 words, but average 200 words each. Cluster highlights contributing editors are encouraged to submit at least one entry every other issue. Unsolicited submissions from the field are also welcomed as contributing editors may not always supply material.

Illustrations

Illustrations including line art and photographs are welcomed, but are not required.

Deadlines

The deadlines for Highlights submissions are: Fall issue–August 1; Winter–November 1; Spring–February 1; Summer–May 1. Late contributions are welcome, but may be held for subsequent issues.

Delivery

Contributions may be sent to the editor via several means. CC:Mail is most convenient for the editor. Simply attach your word-processed file to your cc:Mail cover message.

Contacting the Editor

Cut out and place in your Rolodex

Park Science

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NEW BIODIVERSITY PUBLICATIONS

THE WORLD RESOURCES INstitute has released several new publications on biodiversity:

National Biodiversity Planning: Guidelines Based on Early Experiences Around the World by Kenton R. Miller and Steven M. Landou is a practical handbook that offers background information, case-study examples and analysis, and step-by-step guidelines for planning and implementing national biodiversity strategies and action plans. Intended for use by government, communities, business and industry, and nongovernmental organizations, it presents an illustrative biodiversity planning process based on the real world experiences of 17 regions–Australia, Canada, Chile, China, Costa Rica, Egypt, Germany, Indonesia, Kenya, Mexico, Holland, Norway, the Philippines, Poland, the South Pacific, United Kingdom, and Vietnam– that are already developing national strategies, plans, and programs. The book (ISBN 1-56973-025-3) is 200 pages long, costs $19.95, and is published in collaboration with IUCN and the United Nations Environment Programme.

Kenton Miller has also authored *Balancing the Scales: Guidelines for Increasing Biodiversity's Chances Through Bioregional Management* through the World Resources Institute. This work addresses the worldwide effort to protect biodiversity by setting aside discrete areas for conservation and the problems that accompany this strategy due to the demands of growing human populations in need of more land and resources. As a result, scientists, resource managers, and community leaders are calling for shifting the scale of wildland management programs from national parks and reserves to entire ecosystems. This book makes the case for protecting biodiversity wherever it is found: in farmlands, utilized forests, fisheries, and not just within the boundaries of protected areas. Drawing on case studies from Yellowstone, the Serengeti, the Great Barrier Reef, the Costa Rican La Amistad Biosphere Reserve, and other sites, the author explains the challenges and opportunities of *bioregional* management. Aiming at policy makers and practitioners, he brings light to the core elements of successful projects: building capacity to manage larger, more complex areas; forging negotiated agreements with resource users and other stakeholders in the bioregion; and developing cooperation and support for bioregional programs among area institutions. The book (ISBN 0-915825-85-6) costs $14.95 and is 150 pages in length.

Biodiversity Indicators for Policymakers is a paper that provides a framework for assessing biodiversity conditions and trends at local, regional, national, and global levels. Written by W.V. Reid, J.A. McNeely, D.B. Tunstall, D.A. Bryant, and M. Winograd, it presents 22 indicators that can guide conservation decision making by helping planners to set priorities, influencing new policies, and providing information to determine whether policy goals have been achieved. Organized into three categories, the indicators measure: wild species and genetic diversity; diversity at the community-habitat level; and diversity of domesticated species (crops and livestock). The paper (ISBN 0-56973-000-8) is 42 pages long and costs $12.95.

Finally, *Biodiversity Prospecting: Guidelines for Using Genetic Biochemical Resource Sustainably and Equitably* argues that biodiversity prospecting ventures (as in the case of Yellowstone hot water organisms reported on last issue) will not succeed if they do not promote sustainable development. The authors focus on three institutional elements that will ultimately determine the course of this new industry: organizations, contracts, and national legislation. With detailed chapters on designing institutions to facilitate biodiversity prospecting; biodiversity prospecting contracts; intellectual property rights; research management policies; and science and technology guidelines, this report provides the most comprehensive and strategic analysis to date of what may be a significant growth industry in the 21st century. Available from the World Resources Institute for $29.95, the book (ISBN 0-915825-89-9) is 340 pages in length.

The World Resources Institute is an independent research and policy institute founded in 1982 to help governments, environmental and development organizations, and private business address a fundamental question: how can societies meet basic human needs and nurture economic growth without undermining the natural resource base and environmental integrity?

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National Capital

New Species Documented in *Bio-Blitz*

For 24 hours starting at 5 p.m. on May 31, local scientists, naturalists, and biologists "blitzed" Kenilworth Park and Aquatic Gardens in northeastern Washington, D.C., and found approximately 1,000 species of plants and animals. The idea was to inventory, as far as possible, the species present (and identifiable) during one 24-hour period. The information will be used for a number of purposes, including the continued development of the park inventory and monitoring database and the development of plant and animal lists for the newly created District of Columbia Natural Heritage Program. The activity also demonstrated the concern scientists have for local biodiversity, and gave the National Park Service an opportunity to heighten media and public awareness of the many species that can be found even in a highly urbanized area such as Washington, D.C.

The event went extremely well with participation by at least 25 different agencies (federal, state, and local government), universities, and various conservation. To date, the results from the lab and field work have provided many new records for the park, which include new species of dragonflies (2), damselflies (5), butterflies (2), birds (2), bats (2), earthworms (6), copepods (16, 10 of which have never been recorded within the District of Columbia), fish (1), lichens (10), mushrooms (7), land plants–embryophytes (95), and arthropods (insect groups not already listed–approximately 650 new records). In addition to the new species records, the event was a wonderful opportunity to meet and join efforts with local scientists, naturalists, and biologists. In the future, the park will know who to contact for additional assistance and staff expect some of these participants to return to parks that comprise the National Capital Parks-East for future projects.

Readers may review the Washington Post newspaper article, inventory lists, and additional details of the event through the Internet web site set up for the Bio-Blitz at http://www.im.nbs.gov/blitz.html or by contacting Dan Roddy of the National Park Service at daniel_roddy@nps.gov or Sam Droge of the National Biological Service at frog@nbs.gov.

Allegheny-Chesapeake

Natural Resource Bibliography Project Summarized in Poster Session

Scott Tiffney, in association with Dr. Richard Yahner and Kathy Derge (The Pennsylvania State University) and John Karish (National Park Service), presented a poster entitled "Natural Resources in Our National Parks" at the 1996 Annual Conference of the American Library Association held in New York City. The poster outlined the development of a comprehensive natural resource bibliography database for the Chesapeake and Allegheny park clusters as part of a cooperative project between the National Park Service, The Pennsylvania State University, and North Carolina State University.

Great Lakes

Mussel Relocation Study Under Way

In late July, St. Croix National Scenic Riverway, WI, began relocating freshwater mussels to similar habitat in the same watershed as part of a study to determine the long-term effectiveness of translocation as a conservation measure for endangered mussels and to refine existing translocation protocols. Native bivalves throughout the Midwest, South, and Northeast are threatened by an infestation of the nonnative zebra mussel *(Driessena polymorpha)*. Funded by the National Park Service and directed by the National Biological Service (Dr. Greg Cope and Dr. Diane Waller), the project resulted in the relocation of 450 native mussels into a refugium in the NPS managed zone of the St. Croix River.

Two federally-endangered species, the Higgins' eye pearly mussel (*Lampsilis higginsi*) and the winged mapleleaf mussel (*Quadrula fragosa*) and 15 state-listed species reside in the St. Croix, which supports one of the most diverse communities of native mussels in the Upper Mississippi drainage. The information derived from this study will also be used nationally to establish appropriate methods for conducting mussel relocation projects based upon long-term monitoring results (Cope and Waller, 1995).

Two species of unionid mussels representing the subfamily Ambleminae (pimpleback, *Quadrula pustulosa* and spike, *Elliptio dilitata*) and one representing the subfamily Lampsilinae (Higgins' eye pearly mussel) were collected from the St. Croix River by divers under federal endangered species permits. The 450 mussels were relocated to three underwater 5x5 meter (16.4 x 16.4 ft) study grids, two of which are located in the experimental refugium, upstream, and one that served as a source-site control grid located in the collecting zone. The upstream location supports an existing diverse population of mussels, including the only known world population of the winged mapleleaf. Surrogates to the winged mapleleaf were used in the initial phases of this study rather than risk handling the species itself. The refugium is located upstream of a navigation control site established to regulate boat traffic to vessels that have not been operating in zebra mussel infested waters.

River substrate characteristics, mussel density, species richness, and live:dead ratio data were collected at each grid site. Mussels were measured, weighed, aged, sexed (for the federally-listed species) and uniquely marked prior to transport. Research staff placed the mussels in flow-through tanks that were temperature monitored prior to processing and transported in ice-cooled chests. A quantitative assessment of mussel survival, growth, and substrate characteristics will be made annually for a minimum of 2 years.

Native mussels are the most rapidly declining faunal group in the United States, and freshwater mussels constitute the largest group of federally listed endangered or threatened invertebrates. The St. Croix River supports 38 species of unionid mussels, including the only reproducing population of two federally listed species that are not impacted by the zebra mussel. This project is important in protecting the mussels of the St. Croix and in providing criteria for relocating mussels.

GREAT PLAINS

Homestead Cleans Up Following Tornado

On the night of May 8, a tornado ripped through 10 acres (4 ha) of Homestead National Monument of America, Nebraska, damaging park and neighboring homes, and scattering an estimated 114 tons of wind blown debris over 30 acres (12 ha) of park tallgrass prairie. No deaths or serious injuries resulted from the storm, but the high winds damaged trees, fences, signs, and homes in and adjacent to the park sending fiberglass insulation, wire, plywood, structural beams, drywall, asphalt shingles, and personal items across park lands. In some areas, the debris was 5-10 pieces thick per square foot.

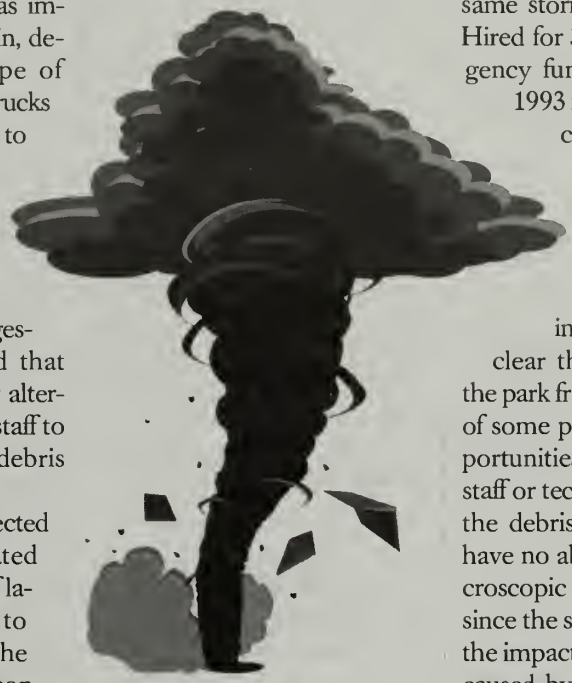
The Homestead tallgrass prairie is a restored cultural landscape that interprets the scene as it appeared prior to the homestead movement of the 1860s. Established in 1939, the 100 acre (41 ha) prairie is the oldest such restoration in the national park system. The debris posed a safety threat to visitors and impaired the prairie itself as the spring growing season began. Immediately, park staff needed to determine the best method of clearing the debris.

At the time, the prairie grasses were 2-3 feet high and the debris was either hard to see or tangled in the grass and emerging forbs. The park posted a message on the NPS cc:Mail Natural Resource Bulletin Board in an attempt to solicit suggestions and accounts of experience dealing with similar circumstances. Among the 25 replies, a few recommended prescribed fire as a remedy; others suggested raking or just leaving the debris; several suggested using volunteer labor.

Though the park identified few hazardous materials, burning was not the preferred alternative due to the proximity of private homes, the presence of asphalt and fiberglass, and the possible encouragement of exotics resulting from burning late in the spring. Raking was impossible due to the terrain, debris materials, and type of vegetation. Using heavy trucks was also impractical due to the long-term damage they would cause from soil compaction. Leaving the debris was not an option and after considering all suggestions, the park decided that hand labor was the only alternative that would allow staff to collect the maximum debris with minimal impact.

After surveying the affected area, employees estimated that about 2,000 hours of labor would be needed to conduct the cleanup. At the time, monument staff consisted of eight permanent employees with no funds for seasonals. Considering the nature of the debris and its effect upon the rapidly growing prairie plant life meant that clean up needed to commence without delay. Continuing rainstorms matted debris into the vegetation as staff began the massive pickup, and they immediately realized they needed considerable outside help.

Using local and regional media, the park proclaimed June to be "Homestead Cleanup Month." Volunteers responded almost immediately. Civic organizations, other agencies, families, and individuals generously donated their time to work under the supervision of park staff and do whatever was needed to clear the debris. To maintain park operations, the park limited the volunteer cleanup effort to 4 days a week. All volunteers received a park orientation and safety flyer when they arrived and a certificate of appreciation for their service. The presence of dangerous materials (nails, glass, etc.) led the staff to restrict participation to volunteers of 16 years of age or older. Furthermore, they checked all volunteers for gloves and boots and made sure that those using chain saws wore approved NPS personal protection equipment. Despite the obvious safety hazards, no injuries were reported.



By late June, the cleanup was complete, although the park will wait until autumn to clear some of the larger trees in heavily wooded areas. During the 7-week effort, park staff dedicated 662 hours to the cleanup. An additional 112 hours were contributed by NPS personnel from the Midwest Archaeological Center in Lincoln and Great Lakes and Great Plains SSO personnel from Omaha. A total of 27 AmeriCorps volunteers contributed 211 hours and 100 community volunteers donated 461 hours of work. The Nebraska Job Service supplied five employees who had been displaced from their jobs when a local store was destroyed by the same storm that hit the park. Hired for 3 weeks using emergency funds remaining from 1993 floods, these workers contributed 500 hours of labor. In all, 160 people contributed 1,953 hours to the effort.

The need for immediate response to clear the debris prevented the park from taking advantage of some potential learning opportunities. The park had no staff or technical ability to map the debris pattern. They also have no ability to measure microscopic soil effects before or since the storm. Effects such as the impact to the microclimate caused by the destroyed trees may be measurable from Long-term Ecological Monitoring Program data; Homestead is a prototype park in the Prairie Parks Cluster for this program.

As the urban-wildland interface continues to expand, this type of incident can be expected to occur more often. Homestead will continue to assess its response plans for handling future natural disasters. Nevertheless, this was a situation when technology provided no ready solution to a messy and unpredictable resource problem. Cooperation, community partnerships, and hard work contributed to our achievements in confronting this situation.

Leopold Institute Endorses Recent Wilderness Publications

Former Sequoia and Kings Canyon National Park research scientist David Parsons points out several worthwhile recent publications from the Aldo Leopold Wilderness Research Institute:

Blahna, D., K. Smith, and J. Anderson. 1995. Backcountry llama packing: visitor perceptions of acceptability and conflict. Leisure Sciences **17(3)**:185-204.

Cole, D., A. Watson, and J. Roggenbuck. 1995. Trends in wilderness visitors and visits: Boundary Waters Canoe Area, Shining Rock, and Desolation Wildernesses. USDA Research Paper INT-RP-483.

Cole, D. 1996. Ecological manipulation in wilderness—an emerging management dilemma. International Journal of Wilderness **2(1)**:15-18. Cole, D., and P. Landres. 1996.

Cole, D. and Peter Landres. 1996. Threats to wilderness ecosystems: impacts and research needs. Ecological Applications **6(1)**:168-184.

Watson, A. 1995. An analysis of recent progress in recreation conflict research and perceptions of future challenges and opportunities. Leisure Sciences 17(3):235-238.

Located in Missoula, Montana, the Leopold Institute is an interagency program aimed at providing the information necessary to protect and manage wilderness resources and values. The National Park Service and National Biological Service are signatories to the interagency agreement providing support to the Institute. Parsons is now the institute director and can be contacted at (406) 542-4190; fax (406) 543-2663; e-mail "/s=d.parsons/ou1=s22l01a@mhs-fswa.attmail.com".

Ecosystem Approach to Forest Management

Professional natural resource managers and the public are increasingly interested in an ecosystem-based approach to forest management. This emerging interest raises the question of how such an approach might apply in a landscape that is dominated by nonindustrial private forest (NIPF) ownerships. Susan M. Campbell and D.B. Kittredge report on the results of a pilot study of a voluntary incentive-based program in one town in western Massachusetts in their 1996 article, Ecosystem-based Management on Multiple NIPF Ownerships. Carried in the Journal of Forestry 94(2)::24-29, their ideas may also be useful to parks as they work with their neighbors on similar issues.

Property Ownership and Habitat Fragmentation

The increased use of private market techniques to protect natural areas raises concern regarding how well these techniques implement nature reserve design concepts. Private market techniques work within the framework of property ownership. In their study, Legal Boundaries and Fragmentation of Georgia's (USA) Nature Reserves, Daryl R. Burkhard and D.H. Newman analyzed the impact that legal property ownership boundaries had on reserve fragmentation and, subsequently, on the potential for habitat fragmentation. The results of the study are reported in the Natural Areas Journal 16(1):24-35.

Groundwater Ecology Book

Groundwater Ecology (1994), a 571 page book from Academic Press of San Diego, CA, presents the status of knowledge about the ecosystems that occur in groundwater. Topics include the hydrodynamics and geomorphology of groundwater environments, the biota of aquifers and other groundwater systems, and anthropogenic stresses on groundwater ecosystems. Edited by J. Gibert, D.L. Danielopol, and J.A. Stanford, the book sells for $74.95.

Forest Fragmentation and Edge Effects on Birds

The early development of forest fragmentation effects on forest organisms is poorly understood, partly because most studies have been done in agricultural or suburban landscapes, long after the onset of fragmentation. John M. Hagen, W.M. Vander Haegen, and P.S. McKinley present a temporal model of forest fragmentation effects on densities of forest-breeding birds, with test data from an active industrial forest in a paper entitled, The Early Development of Forest Fragmentation Effects on Birds. Reported in Conservation Biology 10(1):188-202, the model and data indicate that, for reasons unrelated to traditional edge effects, retaining large tracts of forest can be important because they are relatively free from the variety of plant and animal population dynamics that take place near new edges, including the encroachment by *packing* of individuals displaced by habitat loss.

Monitoring, Natural Processes, and Wilderness

Most monitoring efforts of impacts on federally designated wilderness focus on specific conditions (such as vegetation, soil, water, fish, and wildlife), while the status of underlying natural processes that influence these conditions is largely overlooked. In his paper, Natural Processes: Wilderness Management Unrealized, Michael P. Murray uses four primary natural processes (trophism, gene flow, migration, and disturbance) to assess impacts derived from management within wilderness areas. Management recommendations are offered to provide a foundation for constructive debate on wilderness policy and management. Increased consideration of natural processes may enhance the ecological integrity of wilderness. The study can be found in the Natural Areas Journal 16(1):55-61.

Biology Encyclopedia Available

The *Encyclopedia of Environmental Biology* provides detailed information on issues that affect all resource managers and natural scientists. Edited by William A. Nierenberg, this 1995 work contains 150 articles that explore the impact of global change on plants, animals, and habitats and the causes and cures of environmental degradation. Written for researchers, professionals, and students in environmental science, law, city planning, and public policy, a few examples covered in the book include air pollution and forests, aquatic weeds, processes and loss of biodiversity, bird

communities, biogeochemistry, conservation programs for endangered plants, ecological restoration, equilibrium and nonequilibrium concepts in ecological models, forest insect control, forest canopies, keystone species, insect interactions with trees, packrat middens, population viability analysis, seed banks, and wetland ecology. Available in 3 volumes (2,114 pages), the encyclopedia is published by Academic Press of San Diego, CA, and costs $475.00.

Environmental Magazine Online

Science and the Environment is an online, bimonthly magazine specializing in providing world news summaries on a wide array of environmental issues. Published by Voyage Press, the magazine is designed for high school and university educators and students; it may also interest NPS interpreters who concentrate on natural resource issues interpretation.

The publication takes a multidisciplinary and nonpartisan approach to its coverage, which includes the latest scientific findings, developing government policies, and emerging technologies. The information is organized around eight chapters, including, biodiversity and wildlife health, population and agriculture, marine ecology, clean water, alternative energy and fuels, climate change and atmospheric studies, waste management and recycling, and clean air. Recent features have covered the congressional effort to relax federal wetlands regulations, preserving stopover sites for migratory birds, the spotted owl controversy and prosperity of local economies, and exotic species threats to native Hawaiian plants and animals.

The editors review over 500 magazines, specialized journals, and newspapers to produce each issue, which contains 80 of the most interesting and relevant news stories on important environmental topics. Each story cites the original source and lists contacts for future reference. The publication can be found on the World Wide Web at "http://www.cais.net/publish/voyage.htm#homeport."

Web Sites of Interest

Several World Wide Web sites relate to the natural resource management work of the National Park Service and may be of interest to readers with access to the web:

Aquatic (wetland) Plants
http://aquat1.ifas.ufl.edu/

Biodiversity and Biological Collections
http://muse.bio.cornell.edu/

Biodiversity, Ecology & the Environment
http://golgi.harvard.edu/biopages/biodiversity.html

Biodiversity & Ecosystems Network
http://straylight.tamu.edu/bene/bene.html

Biological Survey
http://www.nfrcg.gov

Botanists
http://meena.cc.uregina.ca/~liushus/bio/botany.html

Ecological Society of America
http://www.sdsc.edu/1/SDSC/Research/Comp_Bio/ESA/ESA.html

Ecology
http://biomserv.univ-lyon1.fr/Ecology-WWW.html

EcoWeb, University of Virginia
http://ecosys.drdr.virginia.edu:80/EcoWeb.html

Entomology
http://www.colostate.edu/Depts/Entomology/WWWVL-Entomology.html

Forestry
http://www.metla.fi/info/vlib/Forestry.html

Landscape Architecture
http://www.clr.toronto.edu/VIRTUALLIB/larch.html

National Biological Service
http://www.its.nbs.gov/nbs/

National Wildlife Refuge System
http://bluegoose.arw.r9.fws.gov/NWRSFiles/NWRSIndex.html

Natural Resources Research Info Pages
http://sfbox.vt.edu:10021/Y/yfleung/nrrips.html

Plant Biology
http://golgi.harvard.edu/biopages/botany.html

PLANTS Database, Natural Resources Conservation Service
http://trident.ftc.nrcs.usda.gov/npdc/

Remote Sensing and GIS
http://wwwrsl.forestry.umn.edu:10000/

Software, Biological
http://www.gdb.org/Dan/softsearch/softsearch.html.

Eastern Old-Growth Forests Examined

Old-growth forest–loosely described as forest that appears largely as it would have if Europeans had not settled North America–is of incalculable value. Old-growth sites can play a key role in plans for restoration of large areas of wilderness. Some, with restoration, could become core areas for future wildernesses, while others could become nodes of biodiversity linked by corridors. Scientists are just beginning to discover ways in which old-growth is biologically unique.

Eastern Old-Growth Forests: Prospects for Rediscovery and Recovery (ISBN 1-55963-408-1 [hardcover] and ISBN 1-55963-409-x [softcover]) is the first book devoted exclusively to old growth throughout the Eastern United States. Edited by Mary Byrd Davis, the book offers authoritative essays by leading experts and is divided into three main sections.

Biological and Cultural Values:

The ways in which old-growth forest differs biologically from second-growth forest, a topic that researchers are just beginning to understand, are explored, and the impact of old growth on the human psyche and the importance of old growth to the culture of Native Americans point to the cultural value of old growth.

Identificaiton:

Single ecosystems, including old-growth forests of southern New England, New York, and Pennsylvania, and of the Great Lakes, are considered.

Preservation and Restoration:

Examples of current preservation and restoration efforts are discussed and recommendations for further work are given.

These essays are framed by an introduction in which Robert Leverett analyzes historic views of forests and current definitions of old growth, and Davis explains the extent and location of Eastern old growth, and an epilogue in which Bill McKibben presents the remnants of original forest as a foreshadowing of the glory of the East's future forests.

Much remains to be learned about old-growth forest. This book will spur further efforts to identify, evaluate, preserve, and restore the forests that are its subject. It is available from Island Press (202) 234-7933.

MAMMOTH CAVE AREA BIOSPHERE RESERVE

Making a difference in groundwater protection

BY JEFF BRADYBAUGH

THE MAMMOTH CAVE AREA Biosphere Reserve (MCABR) was designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1990. It includes Mammoth Cave National Park and its primary groundwater recharge basins, an area totalling 44,700 hectares (110,453 acres). The park is the protected core area, and the basins outside the national park are designated the zone of cooperative use. Located in south-central Kentucky, the area is a karst landscape typified by numerous sinking streams and sinkholes, complex underground watercourses, and a multilayered cave system (longest in the world) with unique fauna and mineralization features. The karst landscape efficiently transports precipitation runoff (and any incorporated contaminants from surface land use) to subsurface streams, posing constant concern for area water quality degradation (fig. 1).

At the suggestion of the National Park Service and others, the Barren River Area Development District (BRADD) selected the UNESCO biosphere reserve model as the tool to address regional water quality issues. Chartered by the Commonwealth of Kentucky, BRADD is responsible for regional planning within the 10-county area surrounding Mammoth Cave National Park. With the biosphere reserve administered through BRADD, whose board of directors consists of locally elected officials, the biosphere program is viewed as a locally managed effort rather than a federal undertaking. As nearly all the land outside of the park is in private ownership, this organizational structure has proven critical to initiating and carrying out biosphere reserve programs.

The Barren River Area Development District established a biosphere reserve council to coordinate resource management activities. The council is comprised of technical specialists from: Western Kentucky University, USDA (U.S. Department of Agriculture) Forest Service, USDA Combined Farm Services Agency, USDA Natural Resources Conservation Service, Tennessee Valley Authority, U.S. Economic Development Administration, U.S. Army Corps of Engineers, agencies of the Kentucky natural resources cabinet, the Resources Conservation and Development District, the Caveland Sanitation Authority, and the National Park Service.

IMPLEMENTATION OF THE BIOSPHERE RESERVE PROGRAM

Several noteworthy programs and projects have been initiated or enhanced through the collective efforts of the governments and agencies cooperating under the Mammoth Cave Area Biosphere Reserve umbrella.

MAMMOTH CAVE AREA WATER QUALITY PROJECT

To protect the Mammoth Cave watershed, a partnership was established with farmers, universities, and agencies to protect aquatic resources by promoting sustainable agriculture and on-the-farm *best management practices* (BMPs). Since 1990, the USDA has made available $950,000 on a cost-sharing basis with local farmers for the design and installation of animal waste BMPs for feedlots and dairies. Agencies, including the National Park Service, have invested $330,000 in groundwater and aquatic community monitoring to assess the effectiveness of BMPs. An Environmental Protection Agency grant has been secured to continue this project over the next four years.

REGIONAL GIS/GPS AND DEVELOPMENT OF A GEOSPATIAL DATA CENTER

Members of the biosphere reserve council have pooled their resources to enhance data sharing and data analysis capabilities. A GIS (Geographic Information System) was established at BRADD to supplement and interact with partner systems. Agencies contributed to purchase a GPS (global positioning satellite) base station that has been used in developing groundwater hazard maps where interstate highways and railroads cross the groundwater basins (fig. 1). The series of maps allows emergency responders to identify sites where hazardous spills from road or rail accidents could enter sinks or otherwise be injected into the aquifer, and allows them to quickly formulate a containment strategy. With support from the Mammoth Cave Area Biosphere Reserve and park assistance via the NPS Lower Mississippi Delta Initiative, the GPS system is being used to map features of a local civil war battlefield, assisting community efforts for its protection. Through a grant from the U.S. Geological Survey (USGS), the biosphere reserve has established a geospatial data center at Western Kentucky University, as a node of the nationwide USGS system.

ECONOMIC DEVELOPMENT AND IMPACT STUDIES

The Economic Development Administration funded a MCABR study to assess the potential for compatible industrial development along Interstate 65 within the reserve. Existing and potential environmental risks and identification of suitable and unsuitable development locations were analyzed. Through the Barren River Area Development District, this information has been made available to the affected communities to assist in economic and infrastructure planning.

The National Biological Service, Michigan State University, and Southern Illinois University are nearing completion of a visitor use and economic impact study for the park and local area. Data will be used to assess the impact of tourism expenditures locally and to formulate regional plans for sustainable tourism currently under development by the West Kentucky Corporation.

Environmental Education

Plans for a nonprofit institute, as part of the biosphere reserve, are being developed to extend and enhance the education and research programs available to local residents and resource managers, including environmental and cultural resource management, sustainability, and heritage appreciation.

To keep the public informed of ongoing water resource management efforts in the biosphere reserve, an educational video was produced through Kentucky Educational Television. It describes the broad concerns of stakeholders, how consensus planning was used to focus on common goals, and the actions taken to enhance water quality. The video emphasizes the progress made through cooperation between businesses, landowners, and agencies working within the reserve.

Mammoth Cave Resources Conservation and Development Area

With the intense focus on water quality in the karst aquifer and the need to remedy related agricultural impacts, agency managers and local officials petitioned the Secretary of Agriculture to designate an area in south-central Kentucky including the biosphere reserve as a resources conservation and development area (RC&D). Established in 1991 and represented on the biosphere council, the RC&D uses its resources to meet goals common to both programs. The RC&D receives USDA funding each year, available for matching grants, to accomplish projects relating to solid waste management, non-point source pollution control, conservation education, and rural infrastructure. While most projects are relatively small in size, they provide rural communities with opportunities to address longstanding problems and to become participants in regional conservation efforts.

Figure 1. The Mammoth Cave Area Biosphere Reserve (gray boundary line—before the recent expansion) encompasses Mammoth Cave National Park (black boundary line) and most of the Groundwater Basin, the primary groundwater recharge area for the cave. The thick gray lines terminating in arrows indicate the flow of precipitation runoff (and contaminants) through neighboring towns and across highways enroute to the cave. The recently expanded biosphere reserve increases opportunities to promote a water quality program throughout the Groundwater Basin that will help protect cave resources.

What the Future Holds

The Mammoth Cave Area Biosphere Reserve, with the national park as the core area, has brought national attention to local conservation issues, including additional financial resources not available previously. Landowners and communities have derived tangible benefits and received recognition for working together to protect resource values. The park benefits in that external resource threats and issues are being addressed and a forum exists to discuss long-term resource protection policies with local officials.

In August, the USMAB National Committee approved expanding the biosphere reserve to 368,000 hectares (909,328 acres). Within the expanded reserve, an opportunity exists to develop greater involvement of rural and small-town residents, to work with commercial natural resource users, and to partner with people interested in conservation of historic resources and the cultural traditions of the region. These opportunities reflect the continuing growth of the biosphere reserve program. In addition to providing a larger land area, the expanded biosphere reserve also continues the focus on areas of critical environmental concern–especially the Mammoth Cave groundwater basins.

Jeff Bradybaugh is Chief, Science and Resources Management Division at Mammoth Cave National Park, Kentucky. Contact him at Mammoth Cave National Park; Mammoth Cave; KY 42259; (502) 758-2251.

Figure 1. Located in southeastern Utah, Capitol Reef National Park nicely frames the Waterpocket Fold, a ridge that runs nearly the entire length of the park. The study took place in the southern end of the park in drainages that cut laterally across the feature.

Figure 2 (left). The Waterpocket Fold viewed from the east. Drainages that contain the rock pools cut across the fold down the gently sloping eastern side.

An Intensive Study of Desert Rock Pool Systems in Capitol Reef National Park

By Toben Lafrancois

ALTHOUGH LOCATED IN ONE of the most arid regions of the Colorado Plateau, Capitol Reef National Park, Utah, contains very unusual aquatic systems. The park is located in Wayne and Garfield counties of South-Central Utah, 40 km (64 mi) west of Hanksville on highway U.S. 24 (fig. 1). The 125,000-ha (308,750 acre) park encompasses the Waterpocket Fold, a 62.5-km long by 1.25-km wide (100 mi x 2 mi) ridge of Navajo sandstone. The Waterpocket Fold contains many drainages cut laterally across its width due to water erosion (fig. 2). Within these drainages are rock pools, which form in series down the drainages (fig. 3). These rock pools are also called *tinajas,* which translates from Spanish as "water jug or tank." As a result of the specific geomorphology of the Waterpocket Fold, these rock pool systems are the best developed in the region (Spence et al. 1993). The Waterpocket Fold contains 80 major drainages including 460 tinajas (Berghoff 1994).

Rock pools in arid systems have received scant attention in the scientific literature, yet they may be the most susceptible of all aquatic habitats to human influences (Dodson 1988). Desert rock pools of the American Southwest are important ecological systems due both to their relative scarcity and their critical functions. Rock pools retain water in otherwise arid systems and are of focal importance to terrestrial wildlife; they also support unique plant communities (Dodson 1988; Spence and Henderson 1993; Van Haverbeke 1990) and are important for use in monitoring ecosystem health. Aquatic macroinvertebrates, which are the major component of Capitol Reef rock pool communities, are often excellent indicator organisms. They are important for monitoring such factors as water quality, anthropogenic disturbances, and other changes that affect the surrounding terrestrial system.

In the park, tinajas range from small, ephemeral pools to larger, permanent pools. Some have accumulated enough sediment to support wetland plant species (fig. 4) including cattails (*Typha* sp.), wetland grasses (*Phragmites* sp.), and black willow (*Salix nigra*). Against the backdrop of one of the most arid regions of the Colorado Plateau, the presence of small wetlands offers a startling contrast.

The Study

The chemistry, biology, and ecology of the Capitol Reef rock pools were studied by Dr. Jill Baron (National Biological Service), Dr. Boris Kondratieff (Colorado State University), and Toben Lafrancois (graduate student, Colorado State University). We gave special attention to the responses of these systems to disturbance. Park resource managers required baseline biological and chemical data on the rock pools for use when making policy and management decisions and when designing educational programs about the park.

We began the study in September 1993 and continued field work until the following September, concentrating on 20 rock pools in five different drainages along the Waterpocket Fold. We sampled the pools on a weekly basis from May to late August 1994. Although intensive, the sampling was nondestructive. We collected macroinvertebrates and anurans (members of an amphibian order that includes

frogs and toads) using a 1 mm² mesh standard D-net, field identified to the lowest possible taxonomic level, and ranked according to abundance categories. Physical and water chemistry data gathered at each pool included volume, temperature, pH, conductivity, and major ions. We also collected rainfall amount from two rain meters in each study drainage on a weekly basis. Chemical data from this project have also been analyzed.

Figure 3. Rock pools, or tinajas, *form in a series down the drainages of the water-pocket fold.*

Figure 4. ne tinajas collect enough diment to support land plant cies such as cattail.

Rock Pool Fauna

Several different groups of aquatic animal species common to the Colorado Plateau can be found in the park rock pools. Of these, most have a highly vagile (free-moving) adult stage, capable of dispersal over large areas. A large number (62) of macroinvertebrate and anuran species occur in the rock pools, about twice what has been reported from other rock pool studies in this area.

Aquatic insects are a major component of the rock pool communities. All typical groups of *lentic* (standing water) insects are found here, often represented by common and geographically widespread species. The northern case-making caddisfly (*Limnephilus taloga*), the small minnow mayfly (*Callibaetis pictus*), and many common dragonfly species were abundant in the rock pools. Aquatic beetles were particularly diverse and abundant. Water beetles commonly found ranged from the minute predaceous diving beetle *(Liodessus affinus)* to the gigantic water scavenger beetle (*Hydrophilus triangularis*). Water bugs such as water boatmen (*Graptocorixa abdominalis*), giant water bugs (*Lethocerus americanus*), water striders (*Aquarius remigis*), and backswimmers (*Notonecta kirbyi*) also can be seen in the rock pools, along with mosquito (*Culex tarsalis*) and chironomid midge larvae (*Phaenopsectra dyari*). These examples represent some of the major groups of aquatic insects in the rock pools, but only a small fraction of the 62 inhabitants recorded to date.

Vertebrates in these pools are represented by frogs and toads, such as the canyon tree frog (*Hila arenicolor*) and the spadefoot toad (*Scaphiopus intermontanus*). Some crustaceans found in the rock pools were fairy shrimp (*Streptocephalus texanus*) and tadpole shrimp (*Triops longicaudatus*). These crustaceans are well-adapted to aquatic life in arid regions.

The animals that compose these rock pool communities are common, hardy organisms that are well dispersed across the Colorado Plateau. Many adult beetles and waterbugs are capable of flight, while other groups such as the crustaceans and spadefoot toads are physiologically adapted to unstable habitats. These characteristics of the rock pool communities suggest that they would recover rapidly from such natural disturbances as floods or drought. During the summer of 1994, floods that occurred due to cloudburst storms did not significantly affect the rock pool communities. Furthermore, we observed no major difference between a rock pool community before a pool dried up and the community that appeared when the same pool was refilled by rain. Rock pools that are components of wetlands, however, support a greater number of species than other rock pools (Lafrancois 1995) and can be expected to act as refugia from natural disturbances. The effects of human disturbances on these systems remain unknown.

Benefits of Monitoring

Several advantages accompany intensive (weekly) sampling of aquatic resources. The number of rock pool species found in this study is over twice the previous park record. The relatively high number of sampling periods provided opportunity to statistically analyze aspects of the rock pools (such as presence or absence of surrounding wetlands) that affect the biological community. Understanding the natural variation of a community, which also requires frequent sampling of the system, is important when developing a data set that will be used as a baseline for a monitoring program. This research provided resource managers with necessary baseline information concerning uncommon and unknown systems. Data regarding the basic biology and ecology of the rock pools are necessary for future ecosystem monitoring and current management and education programs.

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Cover story continued

Where are they now?

Results of a recent informal survey of participants from the first Natural Resource Trainee Program indicate that they have gone on to flourish in natural resource management careers, many of them becoming leaders in their field. Nearly 90% of the first 36 trainees completed the course. Only four did not graduate, and of those, two still work for the National Park Service in resource management related positions. Six are either superintendents or assistant superintendents (one has retired), while ten have become chiefs of resource management. Ten have remained in various resource management positions other than division chief; six have not moved from their original park, deepening their understanding of the resources and their respective ecosystems. Three are system support office natural resource program leaders and two now conduct biological research in parks for the National Biological Service. One became a district park ranger and has put his prescribed fire background from the course to good use. Two retired and two have died. Of three who left government service, one is pursuing a Ph.D. in wildlife biology.

Course participants generally laud the value of the trainee program from both a personal and professional perspective. The program rallied support for the professionalization of natural resource management, provided funding for career development, and gave employees the time necessary to get in-depth, specialized training. Trainees stepped into resource management positions, often as newcomers in parks that formerly had no such expertise, and were given time to develop in this challenging role. Other parks saw the course as an opportunity to improve the level of training of their resource managers without bearing the costs themselves. All trainees developed a rich collection of contacts with subject matter experts. Bruce Rodgers, Chief of Resource Management for the southeast Utah group (Canyonlands, Arches, Natural Bridges) points out that "in those days, few people had a clear idea of what a resource management specialist was supposed to do. This program helped define... those jobs, both for the trainees and for the [National Park] Service." North Cascades National Park Chief of Resource Management Bruce Freet believes the program formed the basis for "a highly visible, fairly rapid... emphasis on science-based resource management."

***The first class of the Natural Resource Trainee Program**—Taken at Colorado State University in Se at the beginning of their 2-year training stint, this photograph appeared on the cover of* Park Science *(v number 2) and accompanied an article describing this exciting new natural resource training opportuni the trainees assembled was for their graduation at Mather Training Center in August 1994.*

Some participants immediately translated training skills into park projects, such as developing an air quality monitoring program for Rocky Mountain National Park or feral animal removal at Haleakala National Park. However, most cite the breadth of the training approach as its main appeal and the source of its success. Participants visited numerous parks and studied resource problems to help them develop the tools needed to deal with diverse issues in the field. "We are not specialists as our titles suggest," one trainee offered, "but daily have to deal with issues that other agencies might have four or five people [to handle]." Natural Bridges National Monument Superintendent Steve Chaney recognized that the course "was not so much a program to teach technical skills as it was a program to teach concepts, instill values, and provide management tools." At the end of the 2-year course, a trainee had developed the broad scope of skills to establish a resource management program in the field.

A further benefit came with the contacts developed between participants and university and private sector experts. Denali National Park and Preserve Chief of Resource Management Gordon Olson indicated that this was one of the most important aspects of the training. "I... designed most elements of my program. This gave me an opportunity to seek training from many sources and to participate in fact-finding trips in various parts of the country. These circumstances allowed me to better appreciate policies and programs of other agencies and to establish a broad network of professionals. In today's climate of partnerships, this knowledge has become extremely important and useful in developing professional relationships."

A Transforming Act

In addition to developing a more broadly trained and networked natural resource workforce, the program also institutionalized resource management in the parks, elevating it to the level of other operational divisions. Rodgers explains, "the trainee program played the single most important role in establishing resource management as a major discipline in park management. It sent forth trained, educated disciples to articulate the need for integrating natural resource considerations with all other management activities. By the early 1990s... dozens of program graduates [were located] in parks and central offices [and were] able to develop and sustain support for resource management budget initiatives and campaign for... separating resource management from ranger activities at the operational level."

Resource management has clearly become better integrated into park management considerations since 1982. Channel Islands National Park Ecologist Linda Dye sees this happening in her park and in general. "We are operating from a base of

Continued on page 18

Table 1. Then and Now—The First Natural Resource Trainees (1982)

	Then	Now
Back Row (standing, left to right):		
1 Harold Werner	Trainee prototype, Southwest Regional Office	Sequoia-Kings Canyon National Park
2 Ben Holmes	Coordinator, Midwest Regional Office	Fire Management Officer, Great Lakes and Great Plains System Support Offices (SSO)
3 Steve Smith	Coordinator, Southeast Regional Office	Fire Management Officer, Atlantic Coast SSO
4 John Lissoway	(First natural resource trainee—completed course at Bandelier National Monument as pilot program for what became the Natural Resource Trainee Program)	Area Fire Management Officer, Bandelier and El Malpais National Monuments
5 Mike Maule	Coordinator, Mid-Atlantic Regional Office	Retired in Santa Fe, NM
6 Steve DeBenedetti	Trainee, Sequoia-Kings Canyon National Park	Deceased
7 Dick Prasil	Coordinator, Pacific Northwest Regional Office	Retired
8 Gordon Olson	Trainee, Antietam National Battlefield	Chief, Division of Research and Resource Preservation, Denali National Park and Preserve
9 Keith Langdon	Trainee, Catoctin Mountain Park	Plant ecologist, Great Smoky Mountains National Park
10 Larry Belli	Trainee, Glen Canyon National Recreation Area	Assistant Superintendent, Everglades National Park
11 John Townsend	Trainee, Indiana Dunes National Lakeshore	Position in ranger activities, Midwest Field Area
12 Bruce Freet	Trainee, Big Cypress National Preserve	Chief of Resource Management, North Cascades National Park
13 Mike Duwe	Trainee, Big South Fork National River and Recreation Area	Environmental Protection Specialist, Sleeping Bear Dunes National Lakeshore
14 Dave Haskell	Trainee, Shenandoah National Park	Director, Grand Canyon Science Center, Grand Canyon National Park
15 Lillian Rummel	Trainee, National Capital Parks-East	Deceased
16 Linda Dye	Trainee, Biscayne National Park	Ecologist-Database Administrator, Channel Islands National Park
Middle Row (left to right):		
17 Ed Schreiner	Trainee, Olympic National Park	Research Biologist, National Biological Service, Forest and Range Ecosystem Science Center, Corvallis, Oregon—Duty Station, Olympic National Park Field Station
18 Hank McCutcheon	Audited courses while at Rocky Mountain National Park	With NBS at Northern Arizona University (?)
19 Steve Budd-Jack	Trainee, Mesa Verde National Park	District Ranger, Mesa Verde
20 Steve Chaney	Trainee, Buffalo National River	Superintendent, Natural Bridges National Monument
21 Ken Stephens	Audited courses while at Bandelier National Monument	Supervisory Resource Specialist, New River Gorge National River
22 Bruce Rodgers	Trainee, Assateague Island National Seashore	Chief of Resource Management, southeast Utah group (Canyonlands, Arches, Natural Bridges)
23 Bob King	Trainee, Padre Island National Seashore	Left NPS, possibly to the Environmental Protection Agency
24 Dave Reynolds	Trainee, New River Gorge National River	Natural Resource Program Leader, Chesapeake-Allegheny SSO
25 Kathy Jope	Trainee, Katmai National Park	Natural Resource Program Leader, Columbia-Cascades SSO
26 Chris Baumann	Trainee, Chesapeake &Ohio Canal National Historical Park	Working on Ph.D. in wildlife biology at the University of Massachusetts
27 Barbara Samora	Trainee, Cape Cod National Seashore	Mount Rainier National Park
28 Jeff Bradybaugh	Trainee, Theodore Roosevelt National Park	Chief of Resource Management, Mammoth Cave National Park
29 Ron Nagata	Trainee, Haleakala National Park	Chief of Resource Management, Haleakala National Park
30 Frank Buono	Trainee, Chaco Culture National Historical Park	Assistant Superintendent for Natural Resources, Mohave National Preserve
31 Len Frank	Coordinator, North Atlantic Regional Office	Retired (possibly in Coral Gables, FL)
32 Steve Cinnamon	Trainee, Wupatki National Monument	Natural Resource Program Leader, Great Plains SSO
33 Gary Ahlstrand	Coordinator, Alaska Regional Office	Chief of Resource Management, Mount Rainier National Park
Bottom Row (sitting, left to right):		
34 Bill Ehorn	Audited courses, Channel Islands National Park	Retired as Superintendent of Redwood National Park
35 Debbie Buzzell	Trainee, Morristown National Historical Park	Left government service
36 Norm Fletcher	Trainee, Acadia National Park	Left government service
37 Brad Cella	Trainee, Wrangell-St. Elias National Park and Preserve	Fire Management Officer, Alaska SSO
38 Garee Williamson	Trainee, Cuyahoga Valley National Recreation Area	Cuyahoga Valley National Recreation Area
39 Walter Loope	Trainee, Pictured Rocks National Lakeshore	Pictured Rocks (NBS field station) National Lakeshore
40 Tim Tunison	Trainee, Hawaii Volcanoes National Park	Resource Management Specialist, Hawaii Volcanoes
41 Jack Gulvin	Trainee, Yellowstone National Park	Retired from Cuyahoga Valley NRA (?)
42 Stan Lock	Coordinator, National Capital Regional Office	National Capital SSO (White House Liaison)
43 Ro Wauer	Trainee Program Founder and Manager, Washington Office	Retired in Victoria, Texas—writing bird finding guides to the national parks and other natural history publications
44 Jon Jarvis	Trainee, Crater Lake National Park	Superintendent, Wrangell-St. Elias National Park and Preserve
45 John Miller	Trainee, Grand Canyon National Park	Chief of Resource Management, Padre Island National Seashore
46 Jeff Connor	Trainee, Canyonlands National Park	Resource Management Specialist, Rocky Mountain National Park
47 Allan O'Connell	Trainee, Fire Island National Seashore	Research Wildlife Biologist and NBS Cooperative Park Studies Unit Leader, University of Maine
48 Joanne Michalovic	Trainee, Mount Rainier National Park	Superintendent, Women's Rights National Historical Park
Not Shown		
Elizabeth Johnson	Trainee, Delaware Water Gap National Recreation Area	Chief of Resource Management, Delaware Water Gap
Cat Hoffman-Hawkins	Supplementary trainee from Mount Rainier—February, 1994. Graduated with 2nd trainee class	Chief of Resource Management, Olympic National Park

Trainees continued

more knowledge than in the past. [We have] input into NPS natural resource management decisions. Attitudes are changing and the need to operate from an informed place is being validated."

In many cases, the trainees themselves have risen to positions of influence and should be able to help continue the integration process into the future. "In a very practical sense," says Bruce Freet, North Cascades National Park Chief of Resource Management, "[we] would not have the [positions] and monies... allocated for natural and cultural resource management that we have today [if it were not for the trainee program]. Our class and others that followed... had an effect on NPS priorities over time. Now, many of us... are in influential management positions, so the effects on the agency could be even greater during the next decade."

Not all changes occurred in parks, however. The training program also launched the National Park Service into new areas of expertise as Frank Buono, now Assistant Superintendent of Joshua Tree National Park, points outs. He views the course as having "provided a basis for developing experience in complex legal and regulatory areas–air, water, minerals, rights of way–that was previously missing." These national programs continue to serve parks well primarily from the newly established Natural Resource Program Center in Colorado.

Over the course of six classes from 1982-1993, the trainee program placed over 140 resource professionals in the parks and helped the National Park Service take a big step forward toward resource management professionalization. The highest percentage of graduates[1] have become resource management specialists (29%), followed by natural resource specialists (17%), park rangers or supervisory park rangers (13%), and supervisory natural resource specialists (5%). Other graduates are biologists; biological, physical science, and GIS cartographic technicians; fire management officers; and environmental protection specialists, etc. Three (as of 1992) are superintendents. According to Bill Walker, Wauer's successor as trainee program manager for courses 2-6, "we continue to see all course participants making strong contributions to the resource management profession. Graduates from even the most recent courses now serve in chief of resource management and superintendent positions, and more and more of them will move up as the 1990s come to a close."

While under way, the trainee program evolved considerably, originally concentrating on just the individual needs of participants. By the mid-1980s, the program changed to combine both park-tailored courses with a core set of academic courses in an effort to make the training more even for all participants. In the end, the program had succeeded in placing the first professional resource managers in many natural resource parks, but it could not be expected to train all NPS resource managers. Subsequently, the emphasis on training in the technical aspects of resource management (e.g., biology, fisheries, wildlife management) shifted. The Vail Agenda and the Strategic Plan for Natural Resource Management, both published earlier this decade, recommended that the National Park Service concentrate on recruiting academically trained resource managers with appropriate degrees and training them in the National Park Service approach to resource management (e.g., compliance, practical aspects of resource management planning, etc.).

What's Next?

The revitalized Albright Employee Development Center is already offering training that shares the NPS-specific approaches to resource management not taught in an academic setting. Designed to cover both fundamentals and advanced topics, these courses will build on the most successful components developed during the Natural Resource Trainee Program.

The natural resource management training manager at Albright, Dennis Vásquez, recently coordinated the ambitious 6-week course, "Fundamentals for Professional Natural Resource Managers." This training focused on developing competence in the areas of NPS resource stewardship, planning and compliance, professional credibility, communications, project and program development, and other areas. Offered last May and June, the course was funded from a central account and was attended by more than 20 park resource managers with an average of 2½ years of NPS employment. Albright will also serve as a natural resource training clearinghouse, facilitating NPS participation in training and professionalization opportunities offered through university short courses and other non-NPS means.

While training is important, Delaware Water Gap National Recreation Area Chief of Resource Management Beth Johnson points out that "we need to be able to attract previously trained, highly skilled scientists to advance our resource management programs. They must complete the inventories that are so much needed, [and] they must design and implement monitoring programs and analyze the data that is produced to meet the agreed upon management objectives for the park unit."

Some of her concerns are addressed in the long-range resource management professionalization thrust that gained focus through the Strategic Plan for Natural Resource Management, the Vail Agenda natural resource careers committee, and the Ad Hoc Report. Now a *stewardship* professionalization plan that includes both cultural and natural resources is in final review and is expected to be released later this year; this document stresses an integrated approach to professionalization as the key to taking resource management to the next tier. Important parts of the professionalization movement include continuing to establish positions with positive degree requirements, carefully recruiting academically trained specialists, retraining NPS staff, encouraging career paths that can lead to superintendencies, and developing natural resource competencies. Also important are enhancing and developing new partnerships, improving our relationships with the National Biological Service and universities, pursuing NR-MAP staffing level recommendations through a separate initiative, and keeping attention focused on Director Kennedy's support of the "Stewardship Today for Parks Tomorrow" initiative to double resource management staff by the year 2000. All are exciting potentialities, but restructuring, reengineering, and diminishing budgets have all made professionalization goals more difficult to reach. However, when the time is right, we are ready to move forward.

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[1] Percentages pertain to 108 graduates from the first five courses as of October 1992.

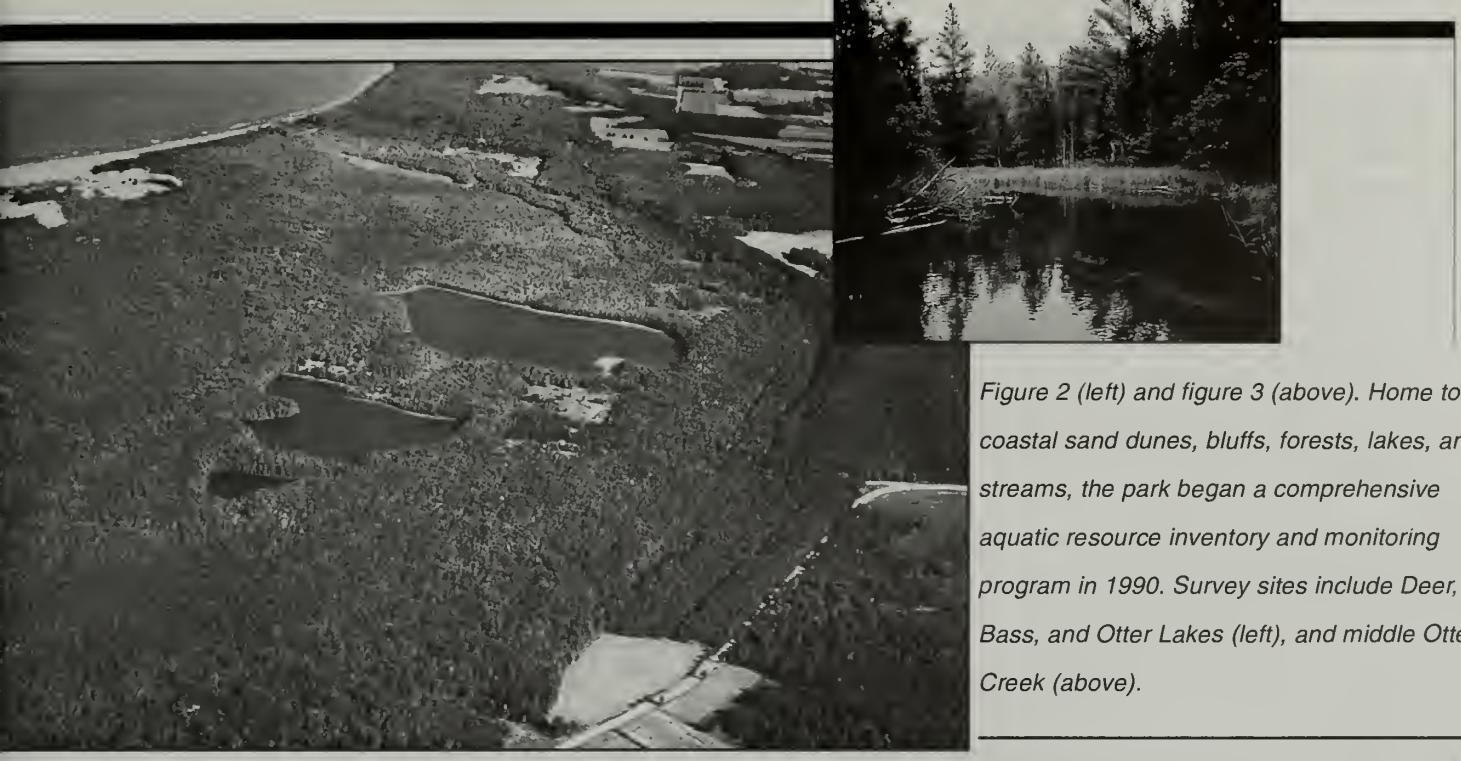

Figure 2 (left) and figure 3 (above). Home to coastal sand dunes, bluffs, forests, lakes, and streams, the park began a comprehensive aquatic resource inventory and monitoring program in 1990. Survey sites include Deer, Bass, and Otter Lakes (left), and middle Otter Creek (above).

Maintaining a Water Quality Monitoring Program at Sleeping Bear Dunes

By Laurel L. Last and Richard L. Whitman

SLEEPING BEAR DUNES National Lakeshore is located on the northwest shore of the Michigan lower peninsula (fig. 1). The park is a diverse landscape of coastal sand dunes, bluffs, forests, lakes, and streams (figs. 2 and 3). Its topography and geology have been influenced by glaciation, erosion, and sedimentation. Although extensive lumbering begun in the late 1800s had depleted the area's forest resources by 1910, much of the cleared land has been reforested since the 1920s. Presently, much of the national lakeshore is covered by pine, aspen, and northern hardwoods. Over the years, tourism has become the number one industry for the local economy. Concern for protection of area natural resources led to park creation in 1970. The lakeshore now provides thousands of visitors each year with a variety of recreational opportunities, from enjoying the outdoors (through hiking, canoeing, fishing, beachcombing, and other activities) to exploring the fascinating history.

Program Beginnings

In accordance with the lakeshore general management plan (NPS 1979), the park initiated a project in 1990 to provide a comprehensive aquatic natural resource inventory and a program for long-term aquatic resource monitoring. During the first 3 years of the program, 1990-92, the NPS Water Resources Division performed a thorough, well-funded aquatic resource inventory. The result was both a report and a manual to guide future lakeshore monitoring efforts (Boyle and Hoefs 1993b and 1993a).

Following the initial 3-year project period, the monitoring program became the responsibility of the park. In 1993, a bachelor-level biologist without specific aquatic training and unfamiliar with the project continued the monitoring program. She collected the data and samples, with help from various other park employees and volunteers, and the samples were analyzed by an outside lab and expert macroinvertebrate specialist. The park received only the data sheets and lab results, with no interpretation or analysis.

Figure 1 (map). Sleeping Bear Dunes National Lakeshore, Michigan.

In 1994, the first author, working for the NBS Lake Michigan Ecological Station, sampled and collected field data (with help from the second author and two park interns); she also analyzed and interpreted macroinvertebrate and water

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quality data. An aquatic ecologist working on her master's degree conducted the monitoring after she received 3 weeks of training at the ecological station. She completed the macroinvertebrate analysis that fall and winter while attending the university. The station performed the water quality analysis using methodology outlined in Whitman et al. (1992) and provided the park with a report (Whitman et al. 1994).

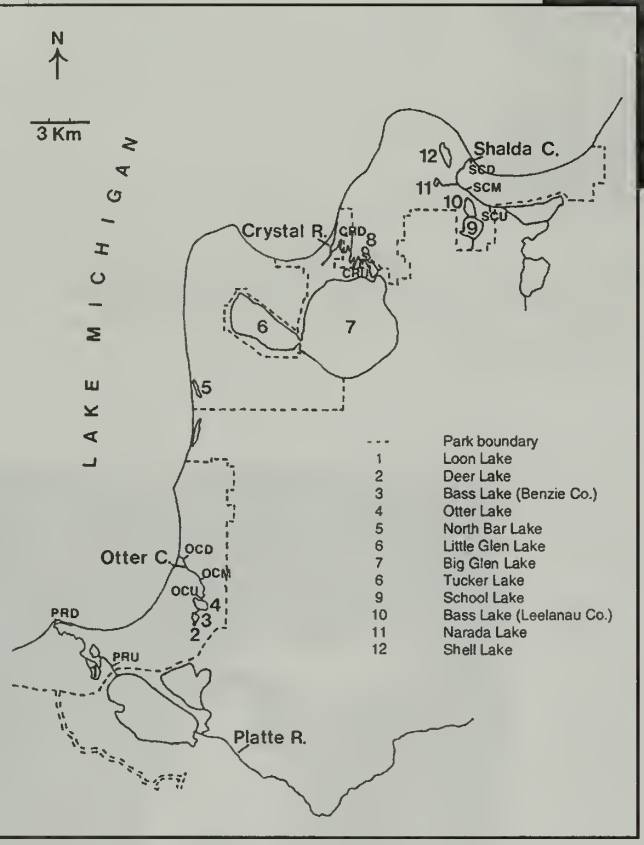

Figure 4. Map of Sleeping Bear Dunes National Lakeshore, Michigan, and the 12 lakes and 10 stream sites under study in 1994 and 1995. (North and South Manitou Islands not shown).

In 1995, we returned with a fisheries biologist and five volunteers and finished the sampling in only 2 days, versus several weeks of effort in 1994. The National Biological Service again analyzed water quality, but had inadequate human resources for the macroinvertebrate analysis.

This article presents an overview of the 1990-95 studies of the Sleeping Bear Dunes monitoring program. It compares logistical approaches used in different years of the program, analyzes problems in maintaining program consistency, and suggests solutions to these problems.

Figure 5. The fi
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Consistency Issues

Data collection methods were generally similar between years (Boyle and Hoefs 1993a and 1993b, Whitman et al. 1994). Staff monitored 21 lakes in 1990. Although 12 lakes were monitored each year thereafter, only 10 remained in common between 1991-92 and 1993-95. The lakes sampled in 1994-95 are shown in figure 4. Lake data collected all years included temperature and dissolved oxygen vertical profiles; Secchi disk transparency (fig. 5); and surface (or "shallow") pH, chlorophyll *a*, nitrate-nitrogen, and total phosphorus. Additional characteristics monitored in 1994-95 included specific conductance (an indicator of ion content) and ammonia-nitrogen. Except for 1993, 10 sites on four streams–Platte River, Otter Creek, Crystal River, and Shalda Creek–were monitored every year (see figure 4 for site locations). Stream data collected included temperature, dissolved oxygen concentration, pH, and benthic macroinvertebrate community composition all years, plus specific conductance in 1994-95. Five benthic macroinvertebrate samples were collected at each stream site using a square-foot (1.0 mm mesh) Surber sampler.

Besides the designed reduction in collected data after the initial 3-year inventory, other differences in methods resulted from personnel, time, and budget decreases and loss of corporate memory. Fewer stream sites were sampled in 1993, and some of the 1994-95 sites were not the same ones sampled during the inventory. The lake samples were analyzed for ammonia-nitrogen in 1994-95, rather than Kjeldahl as in 1990-92, and no nitrogen species were analyzed in 1993. Nutrients and chlorophyll *a* analyses were done for shallow and deep samples from most lakes during the 1990-92 inventory. In 1993, samples were taken as depth composites as outlined by Boyle and Hoefs (1993a). Although depth-composited samples were taken initially in 1994, time constraints soon forced surface grab sampling instead.

One very important difference between years was the length of the data collection period. Although stream macroinvertebrate communities do not usually vary much over the short-term, some lake water parameters can change dramatically from day to day, depending on ambient events, changes in biological systems, and other limnological occurrences. Accurate comparisons of chlorophyll *a* or nutrient concentrations between lakes can therefore only be made if the observations occur within a 1- or 2-day period of comparable

weather. Lake sampling occurred over a 12-, a 4-, and a 5-day period in 1990, 1991, and 1992, respectively. Lake sampling in 1993 occurred over a 51-day period. Although the rest of the lake sampling took 15 days in 1994, samples for (surface) nutrient and chlorophyll *a* analyses were taken within an 8- and a 24-hour period, respectively. In 1995, all of the lakes were sampled in 1 day (12 hours).

Inconsistency in sampling methods restricts an investigator's ability to determine if data changes reflect actual water quality trends, thereby limiting the utility of a monitoring program. However, if methods are carefully recorded, one can determine how comparable the resulting data are. In this monitoring program, some data collection methods (such as exact sampling locations) were not well documented, making replication difficult. However, most methods were well documented. We know, for example, at what depths chlorophyll *a* samples were taken in each lake in each year, and, although the resulting concentrations may not correspond directly, we can still make general comparisons. Although methods consistency is very important, methods documentation is critical.

Lessons Learned

The water quality monitoring program has provided us with valuable insight into the problems, issues, and compromises inherent in the creation and operation of such a program in a world of finite resources. From both our personal experiences in 1994-95 and a study of the project from its initiation, we have learned some lessons that we believe will be useful to those involved with monitoring programs in other parks.

Although mission commitment by the host park and regional office remained impressively strong, many of the problems encountered were related to lack of continuity of personnel and support and the learning curve to be expected for any complex field project. Consistent, reliable commitment and support are imperative not only for program continuity, but also for data integrity and ultimate program survival. Due to fiscal constraints, program scale may be compromised for the sake of program survival, but consistency and continuity of salient programmatic elements must be maintained on some routine basis. Lack of adequate programmatic resources translates to increased turnover in program personnel and experience, resulting in decreased performance, efficiency, analytical accuracy, and consistency, and–most importantly–loss of corporate memory.

There are many programmatic compromises and issues involved in the development and operation of any water quality monitoring program, such as fineness or coarseness of sampling intensity, replication, quality assurance, and spacial-temporal representation. While the former issues are quite important, consistency and program intensity remain the foundation of a quality monitoring program. Nonetheless, modifications to improve accuracy, efficiency, representation, and techniques should be continually considered. While it is possible to maintain program size by decreasing monitoring frequency (e.g., sampling in alternate years), loss of experienced personnel between sampling years remains a critical disadvantage. Also, gaps in information grow with decreased monitoring activity, and the advantages and disadvantages should be weighed in each situation.

Sleeping Bear Dunes and the former NPS Midwest Regional Office management remain deeply committed to a water quality program, as demonstrated by dedicated lab space, acquisition of modern analytical equipment, cooperation and assistance by all management branches of the park, and energy spent to find a source of continued funding. In the end, it is not the money that defines the program, but the dedication of the support personnel. Nonetheless, people drive the monitoring train, and without fuel, neither can go very far.

Although methods consistency is very important, methods documentation is critical.

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Bald Eagle Research in the Apostle Islands National Lakeshore

By Julie Van Stappen and Michael Meyer

A POSTLE ISLANDS NATIONAL Lakeshore is located in far northwestern Wisconsin (fig. 1). It includes 21 scenic islands in Lake Superior and a 19.2-km (12-mi) long strip of mainland. Bald eagles *(Haliaeetus leucocephalus)* (fig. 2) grace the skies above the islands; however, their low numbers have caused concern for both park managers and state resource management partners. Although eagles have increased in Apostle Islands and along the Lake Superior shoreline since DDT was banned in 1972, their reproductive rates have remained significantly lower than mainland populations. After years of monitoring and two research projects, we have begun to answer some questions about the eagle population at Apostle Islands.

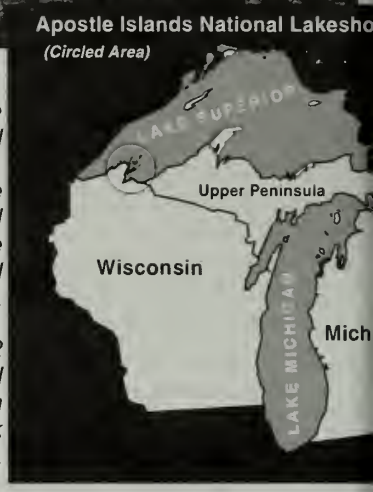

Figure 1 (map). Apostle Islands National Lakeshore, Wisconsin; site of the bald eagle biosentinel research.

Figure 2 (above). Bald Eagle chicks in nest at York Island.

Population Decline

As in most of its range, the bald eagle in the Apostle Islands declined significantly after the widespread introduction of toxic chemicals into the environment. By the 1970s, no more than 24 breeding pairs of bald eagles remained along all Great Lakes shorelines. In the Apostle Islands, bald eagles were absent throughout the 1970s. Between 1980 and 1983, eagles began to reestablish territories here, although they produced no young until 1983.

Eagle research conducted in the park from 1984-86 (Kozie and Anderson 1991) found high levels of contaminants in prey items and nestling carcasses. The majority of food eaten by eagles during the study was fish; however, gull remains were also found in eagle nests. Apostle Islands gulls have high levels of organochlorine contaminants. During the study (Kozie 1991), eagles along the Lake Superior shoreline (including the park) produced an average of 0.9 young/occupied nest with an average nest success of 57%; statewide averages during that period were 1.3 young/occupied nest and 75% nest success.

From 1989-93, the Wisconsin Department of Natural Resources and Michigan State University sampled eaglet blood and found higher levels of PCBs (polychlorinated biphenyls) in Apostle Island eaglets than mainland eaglets; these levels now appear to be decreasing. In 1991, we began a pilot study (Meyer and Van Stappen 1991) to explore causes of lowered eagle productivity in the lakeshore and the impact of toxic chemicals on productivity; we also began to develop a protocol using bald eagles as an ecosystem monitor species for Great Lakes water quality.

Eagles as Indicators

In 1992, The Great Lakes Protection Fund financed a greatly expanded project. A primary focus of this study was to obtain data needed to develop a Great Lakes bald eagle biosentinel protocol; in 1990, the International Joint Commission recommended use of the bald eagle (and specifically its reproductive rate) as a bioindicator of "ecosystem health" and water quality in the Great Lakes basin (International Joint Commission 1990). This multiagency-university study included the Wisconsin Department of Natural Resources, Apostle Islands National Lakeshore, University of Minnesota, and University of Wisconsin.

Before using the bald eagle as a biosentinel, the relationship between contaminants and eagle productivity needed further study. Primary factors suspected of lowering productivity of Lake Superior eagles included environmental contamination, low food availability, and harsh weather.

Research Gets Underway

During the 1992-93 field seasons, we conducted research along the Lake Superior shoreline, including the Apostle Islands, and at mainland Wisconsin bald eagle nest sites (fig. 3). We used direct and remote video camera observations to study eagle behavior through the help of Keith Warnke (University of Minnesota) who focused his master's thesis on analyzing these operations. We also used these techniques to determine nestling food-energy intake by determining the rate of prey delivery. Field metabolic rate on eaglets in control nests was measured

Figure 3. Park tree climbers retrieved chicks for marking and blood samples.

using a doubly-labeled-water technique to validate observational data. Dr. Cheryl Dykstra of the University of Wisconsin focused her Ph.D. dissertation on this technique, which is used to measure energy expenditure by simultaneously measuring metabolizable energy intake in a feeding trial.

Research results indicate that Lake Superior nestlings in broods of one chick received about the same amount of food as did interior mainland nestlings in broods of one chick. However, Lake Superior nestlings in broods of two chicks received *significantly less* food than interior mainland broods of two chicks. Likewise, Lake Superior adults spent approximately 20% less time at the nest during the early nestling stage, and mortality in Lake Superior nests of two chicks was significantly higher than in interior mainland nests (27.3% vs. 8.6%). Nestlings at shoreline nests with two nestlings also modified their behavior to conserve energy by spending significantly less time feeding, being active and standing in the nest, and more time lying in the nest.

We tested the potential relationship between contaminants and productivity by analyzing eaglet blood and addled eggs. Between 1989 and 1993, blood samples were collected from 83 bald eagle nestlings in Wisconsin, 33 of which were along the Wisconsin shoreline of Lake Superior. Lake Superior nestlings contained elevated levels of DDE (a breakdown product of DDT) and PCBs. The highest concentration of PCBs (1,154 ppb) was found on Michigan Island in 1992 in the Apostle Islands National Lakeshore; there the nest is located about 1.6 km (1 mi) from a large herring gull and double-crested cormorant colony. Documentation shows that the eagles fed on both species in 1992.

The mean Wisconsin Lake Superior nestling plasma PCB concentration (100 µg total PCB/l plasma) was three times greater than interior mainland Wisconsin nestling plasma PCBs; however, this level is 45% less than the average plasma PCB concentration for Michigan and Ohio Great Lakes nestlings. Concentrations of DDE and PCBs in eggs collected on Lake Superior declined between 1969 and 1993. The DDE levels in eggs collected during the early 1990s were at or below the level (4 µg DDE/g egg fw [fresh weight]) considered to impact productivity. This indicates that Lake Superior eagle productivity may no longer be affected by these contaminants. In addition, Wisconsin Lake Superior egg PCB levels (14 µg total PCBs/g egg fw) are dramatically less than levels in the 1970s; they are now comparable to Wisconsin River egg PCB levels where productivity rates are excellent.

The research assessed Wisconsin eagle productivity through aerial overflights during incubation and again when chicks were 4-7 weeks old. For more than 25 years, Mr. Charles Sindelar (Waukesha, Wisconsin) and the Wisconsin Department of Natural Resources have conducted these overflights. From 1983-94, productivity of Lake Superior bald eagles was significantly lower than that of interior mainland eagles. However, it has been improving; more than one young per occupied territory was produced during five of the past eight breeding seasons.

We did not find weather to be a significant factor in lowering productivity, with the possible exception of when Lake Superior completely freezes over. For the first time in 17 years, Lake Superior was completely ice covered in January 1994. During the first aerial overflight, six eagle nests in the Apostle Islands were active, but only one nest hatched chicks. Unfortunately, the two hatchlings were later preyed upon. An examination of the failed nests was inconclusive; however, most appeared to have been abandoned during incubation.

Results

Results of this research indicate that the most likely cause of lower bald eagle productivity along the Lake Superior shoreline is low food availability. Low food abundance following hatching may be leading to low food delivery rates to chicks or prolonged adult foraging time away from the nest, resulting (indirectly) in increased chick mortality. The ratio of young produced per *successful* nest is consistently less on the Wisconsin Lake Superior shoreline than at interior Wisconsin nest sites; in raptors this productivity ratio is stable across wide geographical areas, only declining when nests are established in marginal habitat. The Wisconsin Lake Superior bald eagle productivity rate also fluctuates greatly, some years approaching the rate of a "healthy" population, only to be followed the next year by extremely poor reproduction (e.g., 1993–1.03 young per occupied territory; 1994 (Lake Superior ice-covered)–0.33 young per occupied territory; 1995–1.07 young per occupied territory). It is likely that reduced food availability chronically depresses Wisconsin Lake Superior bald eagle productivity and this effect is exacerbated during harsh weather conditions. The Wisconsin Lake Superior bald eagle nest density is low and the rate of increase has leveled off after a rapid expansion in the 1980s; this is in contrast to the rapidly expanding mainland Wisconsin population that continues to grow at an

Before using the bald eagle as a biosentinel, the relationship between contaminants and eagle productivity needed further study.

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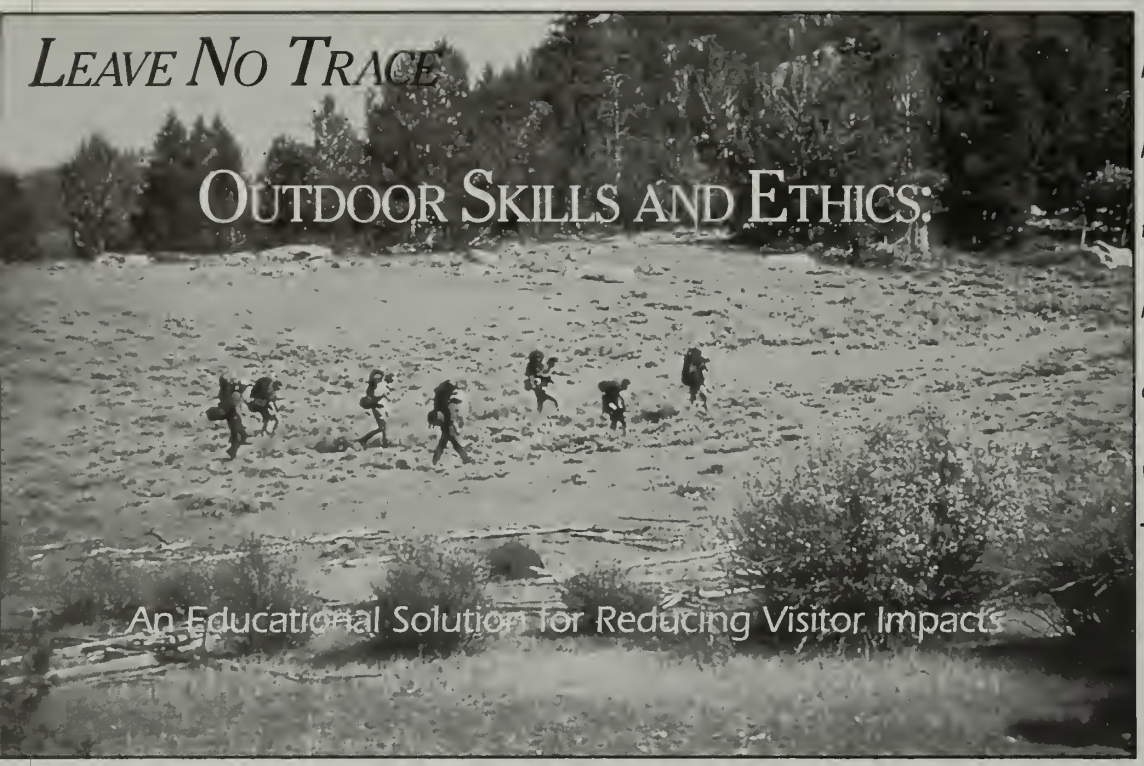

Figure 1. Leave No Trace hiking practices advise off-trail hikers to avoid creating new trails by traveling on durable surfaces and not walking in single file.

LEAVE NO TRACE: OUTDOOR SKILLS AND ETHICS: An Educational Solution for Reducing Visitor Impacts

By Jeffrey L. Marion and Susan Chadwick Brame

VISITORS TO NATIONAL parks and wildlands pose an unintentional but very real threat to the naturalness of these protected environments. Opportunities for recreation constitute a primary purpose for the establishment of these national treasures, challenging managers with the difficult task of balancing recreation and resource protection objectives. As visitation continues to increase, the recurring question, "Are we loving our parks to death?," compels managers to search for new and more effective tools to reach that balance.

In fulfilling their mandate, managers have employed a wide array of direct and indirect visitor management actions (see Marion et al. 1993). Direct actions, such as prohibiting campfires, alter visitor behavior through regulations that reduce visitor freedom, an important element of high quality wildland experiences. Indirect actions, such as visitor education, encourage visitors to voluntarily alter their behavior to lessen the environmental impacts of their recreational pursuits. Educational approaches seek to convey information that emphasizes the linkage between visitation and resource degradation. Camping and hiking practices that reduce visitor impacts are promoted along with outdoor ethics and judgment necessary to guide the selection and application of low-impact skills.

This article describes a new and rapidly growing national *Leave No Trace* (LNT) outdoor skills and ethics program that promotes responsible backcountry recreation (fig. 1). The effort unites four federal agencies–the National Park Service, U.S. Forest Service, Bureau of Land Management, and U.S. Fish and Wildlife Service–and outdoor retailers, manufacturers, user groups, educators, and individuals who share a commitment to maintain and protect our public lands. The primary goal of the program is to develop an educational system that instills the desire and understanding, and demonstrates the necessary skills, to enjoy outdoor recreation in a low-impact manner. The program makes *Leave No Trace* a household name for many Americans, similar to other federal campaigns such as Smokey the Bear and Woodsy Owl.

History and Description of the *Leave No Trace* Program

The *Leave No Trace* program was formalized in 1993 with a memorandum of understanding between the federal partner agencies and the National Outdoor Leadership School (NOLS). NOLS is a nonprofit wilderness school, with international headquarters in Lander, Wyoming. Over the past 30 years, NOLS has taught wilderness and leadership skills to 40,000 individuals on its expedition-based courses around the world. The *Leave No Trace* program had its origins in the 1970s in the U.S. Forest Service, when use of wildlands soared, and education became imperative for wildlands to retain their pristine qualities. However, lack of funding limited efforts until 1991, when the Forest Service approached NOLS to serve as a partner in the program. Further, *Leave No Trace,* Inc., a nonprofit corporation in Boulder, Colorado, was formed in 1994 to oversee marketing efforts and industry fundraising for the program. They function in cooperation with the original partners, representatives of the outdoor products industry, conservation organizations, and major recreational user groups.

The current LNT programs build upon previous educational efforts but are distinguished from their predecessors in three fundamental aspects. First, they are more thoroughly grounded in scientific knowledge from the discipline of recreation ecology. Knowledge from this discipline describes relationships between resource degradation and different types and amounts of recreational use, as modified by environmental factors (e.g., vegetation or soil types) and managerial factors (e.g., visitor management actions).

For example, LNT literature instructs visitors to apply different practices depending upon whether they are in high-use areas or less visited pristine areas. Selecting durable vegetation types and surfaces for travel and camping is also emphasized.

Second, current efforts place substantial emphasis on hands-on training, both of LNT trainers and backcountry visitors. The heart of the program is the Master of *Leave No Trace* Course, a 5- to 6-day field course with three components: 1) low-impact camping and travel skills, 2) wildland ethics, and 3) teaching techniques. Successful graduates teach agency personnel, their constituents, and the public about *Leave No Trace*. Diverse participants in each course enhance the educational experience. Some of the nonfederal participants include members of scouting groups, numerous colleges, private outfitters, and outdoor product industry representatives. Inherent in the LNT training philosophy is the obligation of "masters" to teach and encourage others in *Leave No Trace* skills and ethics. Masters train trainers that can assist them in reaching the public with as much hands-on instruction as possible.

The growing cadre of LNT masters (currently 333 individuals in 32 states, Mexico, and Chile) is supported by follow-up and curriculum assistance from NOLS and participating agencies. The masters are networked through the thrice-yearly Master Network newsletter and the LNT World Wide Web site on the Internet (http://www.nols.edu/LNT/LNTHome). NPS staff who are interested in the Master of LNT training or in receiving the LNT newsletter should contact the NOLS LNT office (1-800-332-4100; e-mail "lnt@nols.edu").

Finally, the current program is developing and distributing a comprehensive set of LNT literature targeted to a wide variety of audiences. The NOLS LNT office distributes 12 different publications and three videos, including a definitive book, "Soft Paths: How to Enjoy the Wilderness Without Harming It" (Hampton and Cole 1995), several national LNT pamphlets and posters, a regional series of LNT outdoor skills and ethics booklets, an activity-specific series (*Leave No Trace* for horseback riders and climbers), and most recently, a LNT booklet developed specifically for Great Smoky Mountains National Park. The program also has a toll-free number (1-800-332-4100) for requesting LNT literature. In the last four months of 1995, NOLS staff received an average of 22 phone calls a day, and sent out 434 LNT mailings. Additionally, LNT literature is posted on and may be requested over the World Wide Web.

Figure 2. Brochures, like the one for Great Smoky Mountains National Park, are one means to publicize the program.

Leave No Trace Pamphlet for Great Smoky Mountains

The need and opportunities for developing specific LNT literature are highlighted in the remainder of this paper. Existing national, regional, and activity-specific LNT literature conveys skills and practices that are widely applicable. However, specific practices, such as selecting and using a pristine campsite, may not be applicable in parks that restrict camping to designated sites. Visitor management regulations adopted by different parks to limit visitor impacts may appear to conflict and may confuse park visitors. For example, Shenandoah National Park minimizes backcountry camping impacts by dispersing camping while their southern neighbor, Great Smoky Mountains, has adopted designated site camping regulations to limit impacts. Camping impacts can be effectively minimized under both impact reduction strategies, but educational efforts must be tailored for each to maximize its effectiveness.

Developing park-specific LNT literature (fig. 2) enables managers to include only those practices that are applicable to their unique environments, activities, and management practices. *Leave No Trace* practices that address particularly troublesome impact problems, such as firewood collection and fire building, can be emphasized. Different LNT practices can be targeted to different user groups (e.g., hikers or horseback riders) or for different park environments (e.g., river or desert). Additionally, LNT information can explain the rationale for visitor regulations and describe low-impact camping and hiking practices that increase the effectiveness of those regulations.

Managers, visitors, and park backcountry resources all benefit from national visibility and consistency of the LNT program. Visitor compliance and ethical understanding are enhanced when educational tools are reinforced and amplified by outdoor stores, the media, scouting and other groups, and park staff. The national program does not replace local educational efforts; it strengthens them by providing a broader context.

I had an opportunity to pilot test the development of park-specific LNT literature during recent campsite and trail survey research that I conducted at Great Smoky Mountains National Park. Along with NOLS and Great Smokies Resource Management Specialist Carol Schell, we developed and submitted a Challenge Cost-Share proposal for NPS funding to create and publish a Great Smokies *Leave No Trace* brochure. The National Park Service and NOLS funded the proposal in 1994 in the amounts of $8,500 and $10,800, respectively.

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Leave No Trace continued

National Outdoor Leadership School project writer Susan Brame worked closely with Carroll Schell during the winter of 1994-95 to write the booklet. They gathered and examined existing park information regarding backcountry regulations, rationale for the regulations, and low impact camping and hiking practices. This information was integrated with LNT practices described in the Southeastern States LNT Outdoor Skills and Ethics booklet and other sources to produce a LNT booklet that is directly relevant and specific to Great Smoky Mountains. Staff at NOLS, the park, and the Virginia Tech Cooperative Park Studies Unit reviewed two drafts of the text that was then sent out for an external review. After incorporating comments and edits, NOLS arranged for printing. Donations from NOLS alumni in the southeastern United States increased funding available for the initial printing. We completed and mailed the attractive 15-page booklet (3½" x 8")in July, and it has been well received.

Like most parks, Great Smokies faces myriad backcountry recreation management challenges, and they must cope with budget cuts that require constant innovation. Through the generosity of a local donor, managers created a short educational video to cover the basics of minimum-impact backcountry travel. According to Chief Ranger Jason Hock, the brochure was integral to the whole process.

The success of the Great Smokies partnership provides a useful model for other parks. Several ongoing LNT partnerships are pursuing slightly different tactics. The NOLS *Leave No Trace* staff is currently working with nine western parks to develop a Rocky Mountain LNT video. NOLS is also involved in a grant-funded, 3-year partnership with the Wyoming office of the Nature Conservancy; the purpose of the project is to gather information about visitor impacts and develop a recreational strategy with LNT education for the Conservancy's Tensleep Preserve.

These examples illustrate only some of the possibilities for developing tools and strategies to improve visitor education. Less intensive forms of involvement might include the distribution of electronic copies of existing LNT literature, with modifications made by park staff. NOLS can serve in a review role to ensure accuracy and consistency and coordinate approval with LNT, Inc., for use of the LNT logo. Every successful partnership, in whatever form, will enhance the next effort.

National Park Service staff interested in exploring partnership opportunities should contact Rich Brame at NOLS. While the level of NOLS involvement is contingent on available funding, they are committed to LNT education and will work with managers to develop strategies that work.

Using research to determine relationships between resource degradation and use, the Leave No Trace Program promotes responsible, low-impact backcountry recreation through education

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Bald eagle research continued

exponential rate. Other contributing factors to lowered productivity include: lowered nest attentiveness; higher predation rates of young; harsh spring weather or extensive ice cover; and somewhat elevated levels of PCB and DDT.

In Closing

Eagle research methods and findings in the Great Lakes have been incorporated in the development of a Great Lakes bald eagle biosentinel protocol. The protocol is currently under consideration for adoption under the Great Lakes water quality agreement between the U.S. and Canadian governments. This protocol, if adopted, will standardize methods used by numerous state, provincial, and federal agencies to collect Great Lakes bald eagle habitat, productivity, and contaminant data, allowing the Apostle Islands eagle population to be put into a regional framework. However, the results of this project must be considered carefully when comparing productivity trends between Lake Superior and the other Great Lakes. In the other lakes, contaminants may be the primary factor limiting productivity, whereas food availability appears to be the primary limiting factor in Lake Superior. This knowledge will enable us to better interpret population trends in the Apostle Islands eagles.

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Turfgrass Research in Washington, D.C. Area National Parks

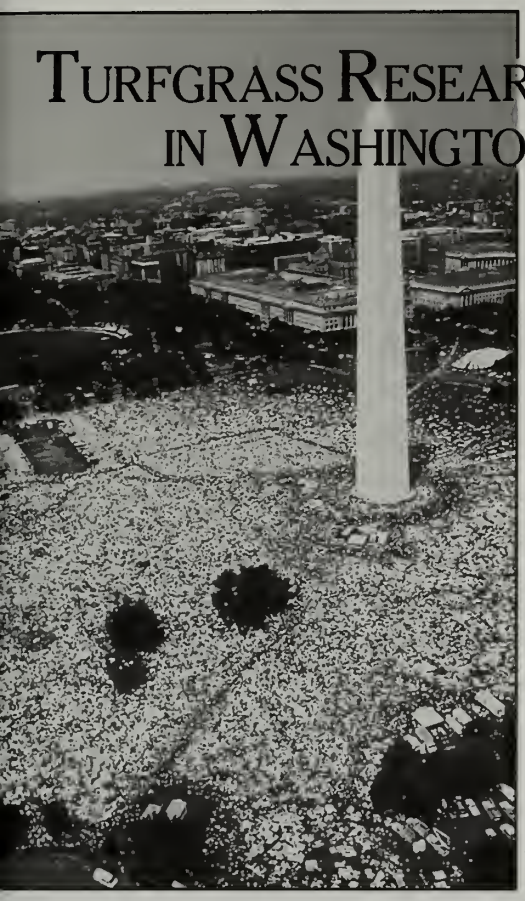

Figure 1. The Fourth of July celebration on the Washington Monument grounds in Washington, D.C., poses a real challenge to turfgrass managers. As many as 1,000,000 people turn out for the annual fete, compacting grasses and wearing them down to dirt.

By Kevin N. Morris and James C. Patterson

Editor's note: *Turfgrasses are predominantly nonnative, require regular care that at times may not be ecologically sound, and are not appropriate in many areas of the national park system. This article does not discuss policy issues related to where and when turfgrass should be used. Rather, it is intended to help managers make wise turfgrass choices in parks where the use of sod is long-established and considered appropriate.*

WHAT DO KITE FLYING, gatherings like the Million Man March, and visiting a soldier's grave all have in common? Each is an activity that takes place on *turfgrass* in units of the national park system. While the presence of healthy sod is not the focus of such activities, it is a key component in providing for visitor use and enjoyment, especially in urban or historical parks.

The demands we make on turf in national parks are diverse and often overlooked. Turfgrass should blend in with the natural surroundings and not become a focal point, whether beautiful, deep green, withered, or dead. In historical parks, turf may need to match the cultural landscape being presented as a snapshot in time. In recreational settings, turfgrass needs to be durable and stand up to constant compaction from large gatherings. Around visitor centers and other park facilities, turfgrass may simply be used to help beautify an area.

Turfgrass, however, plays a much more important role than just providing beauty. Made up of miles of roots, thousands of grass plants per square yard help to conserve and stabilize soil. A thick, healthy turfgrass stand is a natural filter that absorbs great quantities of rainfall, purifying it as it slowly drains into the soil. Grass provides a natural cooling effect on hot summer days by reducing air temperatures at the ground 15-30 degrees Fahrenheit. Turfgrass is also a pleasant, safe surface for informal games and picnics or formal organized sports. The challenge is to develop and keep turfgrass stands that provide these benefits but do not require constant care, pampering, or great expertise to manage.

Managers now recognize the increasing importance of adopting sustainable management practices in both natural and cultural resource parks. For certain park purposes, native grasses may be a good choice for low maintenance, but they may not hold up to the pressures of high use areas. Furthermore, they may not be available for use in many cultural park settings. Turfgrasses on the other hand, require attention that may not be environmentally sound. Use of natural or artificial pesticides, for instance, have potential negative environmental effects and can be costly to purchase and apply. Additionally, nearly all turfgrasses are nonnative.

Turfgrass Research

So how do we select and grow good turfgrass in parks with minimal effort, cost, and disturbance to ecosystems? Turfgrass research has answered many of these questions (see the companion article on turf selection and care on page 30) and continues to be important in making site-specific recommendations. Since 1979, the NPS National Capital Field Area has participated with the National Turfgrass Evaluation Program (NTEP) in conducting turfgrass research. This program is sponsored by the National Turfgrass Federation, Inc., and the United States Department of Agriculture in Beltsville, Maryland, and coordinates testing of over 600 grasses across the United States and Canada. The program accepts new genetic seed stock from seed companies and plant breeders, organizes and mails seed to cooperating colleges and universities and other interested technical participants, collects test results, and releases data summaries. The cooperating university turfgrass researchers prepare, seed, tend, and evaluate the research plots. Each individual test is programmed for a 4-5 year field evaluation. The study period spans different weather conditions and use situations, thus providing an excellent overall evaluation of performance. Also, since tests are located in many geographic

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areas, excellent *cultivar* (short for "cultivated variety," which means improved strain) recommendations can be developed for local turfgrass users in most any area.

The National Park Service is interested in evaluating cultivar performance on heavily impacted, low maintenance park lands. Tests have been planted and evaluated on the Washington Monument grounds, National Mall, and East Potomac Park in Washington, D.C., Prince William Forest Park in Northern Virginia, and Antietam National Battlefield in Sharpsburg, Maryland. The growth conditions at these sites are different from those of the university experiment stations across the continent largely because of the tremendous impact that visitors and their feet have on grass and soil. For example, approximately 1,000,000 people visit the Washington Monument grounds on the Fourth of July (fig. 1, page 27) where the soil compacts nearly as hard as concrete. Likewise, the wear and tear on the National Mall turfgrass is tremendous considering 13-33 million people visit this site annually. In 1991 alone, approximately 2,100 permits, or seven per day, were requested for events as benign as a one-person newscast to very large gatherings on the National Mall. The Gulf War victory celebration brought over 1,000,000 people to the National Mall to view military hardware (fig. 2). Everything from tanks to Apache helicopters to harrier jets were displayed, most on the grass, making the need for sound resource management recommendations obvious (fig. 3).

The lion's share of the cooperative research has been on the Washington Monument grounds. We have planted, grown, and evaluated experimental plots there continuously since 1980. We have tried many grasses and varieties and most have failed the test! Only a handful of Kentucky bluegrass (fig. 4) and perennial ryegrass varieties have delivered acceptable results and even fewer tall fescues have survived over the years.

Conducting research on a national park site is not always as easy as a university or USDA experimental area, for researchers must control as many variables as possible. We go to great pains to find uniform, level soils, provide measured, accurate applications of water and fertilizers, and follow time-honored data collection procedures and analyses. However, at park sites, some variables are not controllable. For instance, construction workers parked heavy equipment on a tall fescue evaluation plot near the Smithsonian Institute and built a fence around it. Another plot was covered with straw and artificial walkways for the display of twelve acres of quilts just 3 weeks after seeding! Trucks, large tents, concert stages, and display booths have all covered our sites, and engineers have constructed new sidewalks through or next to them. Even on occasion, marijuana "grass" seed can be found, so thoughtfully dropped or left behind by others.

Figure 2 (above). The Desert Storm celebration, held in June 1991 on the National Mall, drew 1,000,000 people over 4 days to view 20 pieces of military hardware on display.

Figure 3 (right). Just 6 weeks after being worn to dirt, the same helicopter display site has bounced back solely as a result of watering. Kentucky bluegrass is generally resistant to compaction, but cultivars differ in their resilience—see figure 4.

Other cooperative research projects include testing grasses in heavily shaded areas that have compacted soils and improving a very acidic, pyrite mine spoil site with compost materials in Prince William Forest Park. Antietam National Battlefield offers additional research opportunities for evaluating grasses in a national cemetery. The battlefield is also evaluating a soil amendment for its potential to limit soil compaction in a well-worn grass walkway.

Research Methods

The National Turfgrass Evaluation Program conducts experiments using small (25 square foot) plots of each grass type. Initially, a test area is selected based on suitability to the test. If the primary goal is learning the incidence of disease, then we locate tests in areas with heavy disease pressure or in areas where disease can run rampant. For example, summer diseases need high temperature, high humidity, and moist conditions to thrive. Therefore, areas with low relative elevation or areas next to woods provide additional moisture or restricted air flow that encourages disease development. If the objective is to test tolerance to compaction or traffic, we choose areas that provide a uniform, consistent wear pattern across the experiment. Drought tolerance can be tested using reduced or no irrigation. Cold tolerance can be evaluated by planting the grasses outside their zone of adaptation.

A test area needs to be uniform in soil type, drainage, etc., so that differences in soil or water- holding capacity will not give one grass an advantage over another. All vegetation is removed from the site, the area is cultivated, fertilized, and prepared into a firm, smooth seedbed. Then, a measured amount of each seed is planted using a 5 x 5 ft planting box to prevent the seed from blowing into adjacent plots. After seeding, the entire area is covered with seeding cloth to prevent washing of the seed.

Each grass is planted, or replicated, three times in a random fashion to further negate any differences in soil, drainage, or disease development in the plot

re 4. This national Kentucky bluegrass test plot—var ISI-21—persists in good health 3 years after olishment on the Washington Monument grounds; all surrounding bluegrass cultivar plots have died.

area. Replications allow the researcher to determine if the response of one grass to a particular stress is accurate or happened by chance. If one plot of a cultivar is damaged from disease but the other two plots are not, then uniform disease development did not occur. If all the grasses in one corner of the plot are infested with a particular insect but do not show damage in other areas, then the insect is not distributed uniformly.

The National Turfgrass Evaluation Program has developed a standardized data collection format that all cooperators use when collecting data. Data on many characteristics is collected by the researcher: some data characterize or describe each grass (descriptive) and others record the grasses' response to various stresses. Examples of descriptive characteristics are leaf texture (fineness of leaf), genetic color (shade of green), and density (number of plants per unit area). These characters are collected at many sites and do not vary much from location to location.

Stresses that may influence the quality of a turf stand include diseases, insects, drought, heat, cold, poor soil, low fertility, wear and tear, and others. Researchers attempt to rate the grasses' response to these various stresses as they occur. Often, however, several stresses may affect a grass at one time, making it difficult to separate responses to each stress. Therefore, researchers collect the most important rating, turfgrass quality, each month throughout the growing season. Quality ratings reflect many factors including leaf texture, color, density, disease and insect tolerance, weed invasion, drought, and cold.

Many turfgrass characteristics are subjective, due to personal bias of the researcher. This significantly influences whether a grass receives a high or low rating for turfgrass quality. Some characteristics, such as depth of thatch, can be measured quantitatively. However, measurements of many characteristics are difficult and time consuming to make. Therefore, researchers use the NTEP format and rate most grasses on a scale of 1-9 with 9 being highest quality, darkest green, finest leaf texture, least disease, etc. With proper training, test personnel can become quite proficient in rating grasses quickly and accurately.

After data is collected for an entire growing season, they are assembled and sent to our facility in Maryland. We check the data, correct inaccuracies and perform statistical analyses on each data set. Annual progress reports are produced containing all the data collected on each turfgrass species from each location. These summaries are available for a modest fee.

Applying the Research

The test data have been used for many other national park system areas where recommendations to improve turfgrass are required. Generally the areas most in need of these recommendations are those with large acreages of grass where park visitors tend to gather. By providing the improved turfgrass recommendations, soil test data, and improved management guidelines, a much improved, functional turf stand is achieved. This is particularly important when one considers that over 100 Kentucky bluegrass cultivars are on the market and, without field testing, selecting the right variety for any single site is very difficult. The same is true for tall fescue, fineleaf fescue, perennial ryegrass, zoysia, and other grasses (see Table 1, page 31). For example, "Monopoly" is a Kentucky bluegrass cultivar that has performed consistently better than most grasses tested over the past 15 years on the Washington Monument grounds. This cultivar is lighter green and generally less attractive than many others, but it withstands heavy foot traffic and resulting compacted soils. "Midnight" Kentucky bluegrass, on the other hand, is an attractive, dark green, dense cultivar that has never survived more than 1 year in the Washington Monument tests.

The three research partners have also cooperated to improve the turfgrass quality of the National Mall. This project involved installing a zoysia and tall fescue plot near the Smithsonian Institute and the Capitol. The objective was to provide ideal conditions by encouraging the zoysia in summer and then managing the tall fescue during the winter. This mix provides a good balance as zoysia prospers under hot, dry, and heavy use conditions prevalent in summer, while tall fescue performs well during the cool, moist winter months. This mixture has performed well and remains under evaluation. If it proves acceptable, then the National Park Service will alter its management of the mall turfgrass.

A further example of the usefulness of these data is the need for improved grasses on Liberty Island where the Statue of Liberty resides in New York City. Liberty Island receives heavy visitation and impacts similar to those of the Washington Monument grounds. Data collected at the Washington Monument, other park sites, and nearby Rutgers University in New Jersey, have lead to improved turfgrass recommendations for the Statue of Liberty. Perhaps other parks will benefit from this research.

P.S.

Kevin Morris is the National Program Coordinator for the National Turfgrass Evaluation Program in Beltsville, MD. His phone number is (301) 504-5125. James C. Patterson is a research agronomist for the NPS, National Capital Area in Washington, DC. His phone number is (202) 342-1443.

A Primer for Choosing and Maintaining Healthy Turf

By Kevin N. Morris and James C. Patterson

RESEARCH, AS DISCUSSED IN the article on page 27, is important to fine tune turfgrass recommendations to a specific park or for a particular function. However, much basic information on the attributes of various turfgrass varieties is already available from earlier studies and may be helpful to park managers.

The first step in growing good turfgrass with minimal effort, cost, and disturbance to ecosystems is very basic–choosing the proper grass for the geographical area and intended use. Grasses come in many varieties and flavors, but can be broken down into two categories: cool-season and warm-season. As the name suggests, cool-season grasses grow best in spring, winter, and fall, and prefer the cooler areas of the United States. Extending the Mason-Dixon line west across the country roughly gives the southern border of this region. Logically, warm-season grasses that grow best in warm, summer temperatures, are best south of the Mason-Dixon line, right? Unfortunately, the line is not nearly this clear-cut. Many of the warm-season grasses do not like cold, winter temperatures that prevail from Maryland south to Georgia and even to the mountains of, say, Arizona. Therefore, the grass-type decision process is quite muddled and very confusing at times.

To further complicate the issue is the consideration of the location and use for that grass. Is the area in full sun or shade? Is the soil acidic or alkaline? Will hordes of visitors trample the grass? Many other questions are pertinent, but the point is that choosing the best turfgrass is work! While managers should expect to give attention to the care of turfgrass, choosing the right grass from the start will minimize problems and reduce costs down the road (Table 1).

Cool-season Grasses

Cool-season grasses have the widest distribution and greatest use in most areas of the United States. The most popular cool-season grasses are Kentucky bluegrass *(Poa pratensis)*, perennial ryegrass *(Lolium perenne)*, tall fescue *(Festuca arundinacea)*, fineleaf fescue *(Festuca rubra)* and creeping bentgrass *(Agrostis stolonifera)*. None of these grasses are native to the United States. Most were brought from Europe when immigrants or sailors crossed the Atlantic with seed or bedding for cattle on board.

Kentucky bluegrass (which did not originate in Kentucky, but grows well there) is widely used because it is attractive, forms a dense sod, and comes in many variants. Some Kentucky bluegrasses are very tolerant of foot traffic, while others tolerate acidic soils, shade, or drought. Unfortunately, no single Kentucky bluegrass has all these characteristics; you must first identify your needs and choose accordingly.

Perennial ryegrass germinates fast, quickly establishes ground cover, and is also fairly tolerant of walking or sports-related wear and tear. Its downfall, in the humid states, is its susceptibility to damage by summer diseases.

Tall fescue is heat and drought tolerant while requiring less fertilizer and water than perennial ryegrass and most Kentucky bluegrasses. The "transition zone," an area that is too cold in winter for many warm-season grasses and too hot in summer for many cool-season grasses, is the best area for use of tall fescue. It does well in acidic soils, but does not tolerate compacted soils. Therefore, it is not the best choice for most heavy traffic areas.

Fineleaf fescues (a general term for six different grass species) are excellent in shade and also perform well in poor, acidic soils. They require a minimum of fertilizer and water and perform poorly when too much fertilizer is applied. These varieties tolerate compacted soils very poorly and are not suitable for high visitation areas. Very low maintenance areas, such as cemeteries and roadsides, are traditionally where fineleaf fescues have been used, but they are making their way into more turf settings.

Creeping bentgrass is a specialty grass used mainly on golf courses and probably has very little utility in most national parks.

Warm-season Grasses

Warm-season grasses, such as Bermudagrass *(Cynodon sp.)*, zoysiagrass *(Zoysia sp.)*, centipedegrass *(Eremochloa ophiuriodes)* and St. Augustinegrass *(Stenotaphrum secundatum)*, like their cool-season counterparts, are native to other parts of the world, coming here via settlers or travelers. Buffalograss *(Buchloe dactyloides)*, on the other hand, is native to the U.S. Great Plains. These grasses thrive in summer heat and are more tolerant of drought, in general, than the cool-season grasses. Warm-season grasses vary, however, in their ability to tolerate extreme drought, cold winter temperatures, and disease.

Bermuda grass is probably the most widely used of the warm-season grasses. Bermuda grass spreads very fast and forms a dense sod with very good drought and wear tolerance. Hybrid Bermuda grasses form a very dense, fine-textured turf but require higher maintenance than available at most parks. Common Bermuda grass will survive with less care than the hybrids but still requires a higher level of maintenance than some other warm-season grasses.

Zoysiagrass spreads much slower than Bermuda grass but forms a denser sod with lower fertility requirements. Many zoysiagrasses are very cold tolerant and will survive winters in the northern United States.

Centipedegrass is fairly coarse-textured and slow-growing but needs less fertilizer and water than any of the other warm-season grasses. The cold tolerance and wear tolerance is medium to low. St. Augustinegrass has very coarse leaves and forms a sod that feels "spongy." This grass spreads quickly and has the best shade tolerance of any of the warm-season grasses. However, this grass also has the least tolerance of cold and wear.

Grass Care

After choosing and establishing a grass, a manager needs to consider mowing, fertilizing and watering the turf. Since turfgrasses are often not cut or mowed in nature (except where grazed by animals),

able 1. Advantages and Disadvantages of various grasses

ariety	Pros	Cons
ool-season grasses	Grow best during cool season and cool regions of U.S.	
entucky bluegrass varieties	Tolerant of foot traffic, acidic soils, shade, and drought	No single variety offers all these characteristics
erennial ryegrass	Germinates and covers quickly; fairly tolerant of soil compaction	Susceptible to summer diseases
ll fescue	Heat and drought tolerant; uses less fertilizer and water than perennial rye and kentucky bluegrasses; does well in acidic soils	Does not tolerate compacted soils
neleaf fescue varieties	Excellent in shade and acidic soils; require little fertilizer and water; good for low maintenance areas like cemeteries and roadsides	Intolerant of compaction
eeping bentgrass	Specialty grass of golf courses	Large water volume and high maintenance
arm-season grasses	Thrive in summer heat; tolerant of drought	May not do well in transition zone to cold areas; vary in ability to tolerate extreme drought, colder temps, and disease
rmuda grass	Spreads fast; dense; drought and wear tolerant	Requires higher maintenance than some other warm-season grasses
brid Bermuda grasses	Spread fast; dense; drought and wear tolerant	Require higher maintenance than Bermuda grass
ysiagrass	Forms dense sod with low fertilization requirement	Spreads much slower than Bermuda grass
ntipedegrass	Needs least water and fertilizer of any warm-season grass; forms denser sod, with less fertilization, than Bermuda grass	Spreads more slowly than Bermuda grass; course-textured; slow growing; medium to low cold- and wear-tolerance
. Augustinegrass	Very course leaves give a spongy feel; spreads quickly; best shade tolerance of any warm-season grass	Least cold- and wear-tolerance

mowing is the maintenance practice that can most easily damage turfgrass stands. Therefore, proper mowing procedures are essential for healthy grass that is able to withstand weeds, diseases, and insects. A good guideline is to never remove more than one-third of the height of the grass with any one mowing. Grasses need an adequate amount of leaf tissue to perform photosynthesis and produce enough food to survive and thrive. Removing more than one-third of these leaves weakens the grass plant and may force it use stored food to "breathe." In addition, a sharp mower blade is important to produce a clean cut of the leaf blades and not cause damage to the tip of the grass plant. Finally, cutting height varies depending on the grass and needs to be researched and monitored for each mowing. Mowing shorter than a grass can withstand will severely damage the turf stand and will reduce the density of that stand, creating opportunity for weeds to invade.

Fertilization may or may not be performed in many national park sites, but it is important to understand the most important nutrients required by grasses. Nitrogen is the single most important element needed by grasses. Nitrogen causes leaves and roots to grow and improves the green color. Nitrogen can be overused however, therefore care should be taken not to apply more than the grass needs for adequate growth. Since the need for nitrogen varies with the grass type, consult a knowledgeable source for guidance. Phosphorus is the second element that is important for turfgrass survival. Phosphorus applications are most important during establishment of new seed or grass plants. After grasses are well established, phosphorus requirements are much lower than nitrogen requirements. Potassium, the third nutrient of importance, is probably not used enough by turfgrass managers. Potassium increases the heat, cold, drought, and wear tolerance of turfgrasses. Annual application rates of potassium that at least equal the rate of nitrogen used will help grasses to survive stressful periods.

Watering, or irrigation, is the final critical maintenance practice for turfgrass success. In many park situations, irrigation may be unavailable, impractical, or inappropriate. In many areas, such as the desert southwest, grass cannot be grown without supplemental irrigation. Therefore, water may be the limiting factor in growing good turfgrass. In many other areas, turfgrass can be grown successfully without irrigation, providing that the grass has an opportunity to first become well established. Irrigation, like fertilization can be overdone to the point that diseases and weeds become problems. Also, irrigation that promotes excessive grass growth during a stressful period, such as summer, may not allow grasses to "harden-off," or slowly prepare for stress. If irrigation is suddenly stopped, for economic or logistical reasons, the turfgrass will likely suffer more than if it were not irrigated and allowed to shut itself down. Most grasses can withstand at least some heat and drought stress and should, in most cases, be allowed to do so. If the area is needed as an attractive focal point for the park or for the safety of organized sports participants, then irrigation may be essential to ensure consistent turfgrass cover.

Meetings of Interest

SEPTEMBER 9-20 Front Royal, Virginia, will be the venue for the technical conference, Biodiversity Monitoring at Permanent Plots. Contact the Smithsonian Institution/MAB Program, 1100 Jefferson Drive, SW, Suite 3123, Washington, DC 20560; fax (202) 786-2557, for more information.

SEPTEMBER 14-19 Florence, Italy, will play host to the 17th International Meeting for specialists in air pollution effects on forest ecosystems. Entitled, Stress Factors and Air Pollution, the gathering will focus on recently discovered effects of air pollutants on forest ecosystems, with special reference to the interactions between environmental stress factors. Sessions include: interactions between air pollutants and abiotic and biotic stress factors; impacts on wildlife and ecology; air pollution and global change; and biodiversity conservation. For more information, contact Dr. E. Paoletti; C.S. Patologia Specie Legnose Montane; CNR, Piazzale delle Cascine 28; I-50144 Firenze; Italy; phone 39-55-368918; e-mail: "raddi@cspslm.fi.cnr.it".

SEPTEMBER 28-OCTOBER 3 Istanbul, Turkey, is the venue for Ocean Pulse: A Critical Diagnosis–Our Global Oceans as Earth's Last Frontier and Door to the Past. This international conference will devote 3 days to examining three themes: how we can improve our harvests from the seas while preserving their sustainability into the next century; why historic shipwrecks should be excavated by archeologists; and what marine and biotechnologies will be required to better understand our oceans into the 21st century. Cosponsored by the Explorers Club and the Turkish government, the conference is being coordinated by Dr. John Loret, President Emeritus of the Explorers Club, and Dr. John Tanacredi, NPS Chief of Resource Management, Gateway National Recreation Area. A 12-day eco-tour of the Mediterranean is available following the conference. Conference cost is $2,168 including airfare from New York City; the eco-tour is an additional $2,895. Fax your registration to (212) 888-9819.

OCTOBER 19-21 The American Society of Landscape Architects will hold its annual meeting in Los Angeles. This exposition will focus on compelling evidence of landscape architecture work in planning, design, and technology that contributes to societal well-being. Contact Cheryl Wagner (Fax: 202-686-1001; e-mail: "cwagner@asla.org") for more information.

OCTOBER 25 Bandelier National Monument, Santa Fe National Forest, and the Los Alamos National Laboratory are co-hosting a no-fee Symposium of Biological Research in the Jemez Mountains, New Mexico, in Santa Fe. Contact Stephen Fettig ("stephen_fettig@nps.gov"; 505-672-3861, ext. 546), NPS Wildlife Biologist at Bandelier, by July 1 if you are interested in making a presentation; abstracts are due September 15.

DECEMBER 8-11 The 1996 Midwest Fish and Wildlife conference will take place in Omaha, Nebraska. Organized around the theme, "Sensible Management of Today's Altered Ecosystems," the gathering should interest ecosystem researchers, conservation biologists, and managers alike. Contact Jill Medland of the Great Plains System Support Office for further information at (402) 221-3994; e-mail: jill_medland@nps.gov.

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Improving Resource Management
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Denver, CO 80225-0287

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PARK SCIENCE
Integrating Research and Resource Management

Volume 16—Number 4 National Park Service • U.S. Department of the Interior Fall 1996

Butterflies and Moths of National Parks, State Parks, and National Wildlife Refuges

A Survey Reflects a Growing Interest in Managing for Lepidoptera

By Don Riepe and Barbara Toborg

Photo by Don Riepe

Figure 1. Instantly recognizable, the tiger swallowtail nectars *at orange milkweed (butterfly weed), a prairie perennial that attracts many lepidoptera.*

THE RECENT proliferation of butterfly field guides and gardening books, butterfly farms and observatories, and the formation of the North American Butterfly Association, attests to an increasing public interest in the study and enjoyment of *lepidoptera* (butterflies and moths). Because they can live in relatively small habitats, butterflies and moths make ideal subjects for "watchable wildlife" and other environmental education programs—even in heavily urbanized areas. Butterflies add color and movement to the landscape and have an aesthetic appeal to many visitors. Some, such as the monarch butterfly, migrate by the millions across the lower 48 states on their annual journey to southern California, Texas, and Mexico. A group entitled "Friends of the Monarchs" monitors the monarchs as they winter at Pacific Grove, California. Last winter (1995-96), upwards of 50,000 monarchs delighted visitors from all over California, nearby states and Hawaii, including tourists from France and Switzerland.

As plant pollinators (figure 1), lepidoptera play an important role in natural ecosystems. Many species serve as indicator species or environmental "barometers" whose presence or absence tells us something about the state of an environment. As components of food chains and webs, lepidoptera (especially caterpillars) provide sustenance for small mammals and many species of birds, especially during nesting and migration periods when food demand is high. Among the million plus insects presently described, butterflies and moths are perhaps the most well known and best loved. Therefore, from a public agency perspective, lepidoptera make ideal subjects to consider in resource management and landscaping plans and for interpretive programs.

Natural Areas Surveyed

In order to get some general overview of the current status of interest and management concern regarding lepidoptera in park systems in the United States, we developed

Continued on page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 16—No. 4 • Fall 1998

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations–materials do not undergo refereed peer review. The bulletin is published in January, April, July, and October for distribution to interested parties. *Park Science* is also online on the World Wide Web (ISSN-1090-9966) at *http://www.aqd.nps.gov/natnet/nrid/parksci.*

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to the National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Please refer to guidelines published in volume 16(3):5-6 and online, or contact the editor:

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Printed on recycled paper

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FEATURES

IN THE NEXT ISSUE. . .

In winter, we will take a look at snowmobile emissions research at Grand Teton National Park. Also, Lake Mead Wildlife Biologist Mike Boyles will share his perspective on desert tortoise research, protection, and recovery in the Mojave Desert parks. Other articles are planned, including a report on deer reductions at Gettysburg National Military Park and a brief account of the establishment of the Biological Resources Division within the U.S. Geological Survey, but plenty of space is available. Please contact the editor if you have a story you would like to contribute.

Evolution as Process

Like the organisms many of us study or the organization we work for, our work in resource management and science evolves. Always short on time, staff, and money, we persevere, focusing on what is important–making progress and bringing about results. However slow or gradual the evolution process and however many setbacks we experience along the way, we always seem to march forward making new discoveries, seeing new connections, improving on the way we manage our respective areas of responsibility. This process, this evolution of building on knowledge, applying tools in new ways, of making refinements in what we do is demonstrated throughout this issue.

Two articles discuss different aspects of the survey or questionnaire as a tool to gather information and make advances. In our cover story, Don Riepe and Barbara Toborg report on their use of a survey to investigate the status of management of butterflies and moths in many northeastern U.S. parks. In their case, the survey served as a catalyst for many parks to begin considering these insects in their resource management plans and activities. Information from the questionnaire has also turned into a resource in itself, giving parks access to a network of resource managers with experience in lepidoptera management. Surveys also help us judge the impact of our work on others as the *Park Science* reader survey summary explains. In providing feedback, this survey has created a foundation for making future improvements.

Conferences are a part of this evolution, too. For example, discussions about the NPS "natural process" wildlife management policy at the Ecological Society of America meeting facilitated feedback from supporters and critics as we consider possible refinements of this management approach over the next couple of years. The Tall Timbers gathering in Idaho last spring pulled together an exciting collection of ideas and experiences with prescribed natural fire and may help to further the successful use of this ecologically important management tool in parks.

In her article on natural resources and park construction, Abby Miller explains a refinement in the process to evaluate construction project proposals. Now, the process takes into account multiple benefits to a park, including those related to preserving natural resources. This administrative change represents another significant development in the evolution of carrying out natural resource management work in the parks.

To venture to the next step for each of us certainly requires desire, courage, perspective, and time. As Ralph Waldo Emerson said, "The years teach us much the days never knew." Stay focused, keep pushing, be creative, take chances. The next step may be just within reach.

News & Views

Erratum

Keith Langdon, the inventory and long-term monitoring coordinator for the last 3 years at Great Smoky Mountains National Park, wrote to say that he enjoyed the cover story about the Natural Resource Trainee Program last issue. He also pointed out an error; he is not a plant ecologist as listed in the key to the photograph on page 17. Rather, his title is Supervisory Biologist. As he put it, "I do work with plants, but also just about every other form of life here."

Changes

Several minor changes related to *Park Science* (online) are afoot. First, it has a new World Wide Web address and can be found at http://www/aqd/nps.gov/natnet/nrid/parksci. An online, integrated infobase of this year's issues (volume 16) is now up and running and, for some readers, may be easier to use than downloading the PDF (portable document format) files that have been the only choice so far. You can reach the infobase from the *Park Science* home page. Likewise, text files of the articles are also available from the web site and the editor is considering a method to distribute them to interested parties via NPS cc:Mail. Also, *Park Science* (online) has been assigned an international standard serial number (ISSN 1090-9966) by the Library of Congress. This official registration should help make the information easier to locate on the web and in print. By the way, the U.S. Government Printing Office maintains links to federal publications, including this one, from their home page on the web (http://www.access.gpo.gov/su_docs/dpos/btitles.html).

New E-mail Address

The George Wright Society (GWS) recently adopted a new e-mail address and unveiled a web site. You can reach them by e-mail at gws@mail.portup.com and explore their web pages at http://www.portup.com/~gws/home.html. The home page features basic GWS information, including an online membership signup form, a complete GWS publications list and order form, a George Wright Forum sampler, and information on the upcoming 1997 GWS conference (see Meetings of Interest on page 32). Abstract submission guidelines and registration forms for the conference are available. The site also sports an ever-changing list of other relevant web sites for park researchers and managers.

Conservation Directory Available

The U.S. Fish and Wildlife Service, Montana Fish and Wildlife Management Assistance Office, has compiled a national directory of Native American Conservation Departments. Each listing is of an active tribal conservation program. A resource such as this may be useful to many parks and other land managers in establishing contact with tribal liaisons regarding conservation issues and goals on adjacent federal and tribal lands. Contact Joe

Continued on page 4

Early at (406) 585-9010 in Bozeman, Montana, for a free copy.

Readers Generally Satisfied Concludes Survey

Results from last year's *Park Science* readers survey are in and the general word is that most readers are satisfied with the publication. Distributed to over 4,200 readers and returned by 16% of them, the survey asked 16 questions specific to *Park Science* including questions about the readers themselves, content, distribution methods, electronic publishing, design, and how the information is used. A summary of the findings follows.

The profile of a typical *Park Science* reader yielded few surprises. Sixty-one percent of the questionnaires were completed by NPS employees, 11% by university staff, 6% by NBS employees, 5% by other federal agency staff, and 5% from other organizations. Responses came from 50 states and territories of the United States with western states leading the pack. Eight countries responded with Canada leading this group.

Within the National Park Service, responses came from 156 different units of the national park system and at least 15 administrative units. Thirty-five per cent of readers have completed a master's degree, while 22% have earned a bachelor's degree, and 20% have a Ph.D. Fifty-eight percent indicated a resource management background, with biological sciences running a distant second at 27%. The average pay grade of a *Park Science* reader is GS-11.

Most respondents are long-time readers of this publication (55% greater than 5 years) and learned about it through the former Natural Resource Publications Office or a colleague. While seventy-eight percent are happy with receiving the publication by mail, most respondents also indicated that Internet access or other electronic distribution (such as cc:Mail) would be beneficial.

Nearly three-quarters said they read *Park Science* cover to cover, and 71% save it for future reference. The three most common uses for the information were to contribute to general knowledge of natural resource issues (90%), to keep up with NPS natural resource management and research (88%), and to learn of new activities and techniques (64%). Twenty percent use the information to make a decision about a management issue. Clearly indicating general satisfaction, over 90% consider the publication very useful or somewhat useful.

Regarding content, 81% feel that the mix between technical articles and science and resource management news is about right. The most popular sections are feature articles and case studies (88%) and the Highlights department (78%). The Editorial, Meetings of Interest, Book Review, and Information Crossfile are read by approximately half of the recipients. Least popular is the MAB Notes department (33%).

Despite general appeal, *Park Science* can be improved as 38% of recipients pointed out. While the list is too long to share in its entirety, the most common suggestions (in descending order) were to include articles on: social science research applications; geology (caves) and paleontology; exotic species; restoration ecology; coastal and marine resources; integrated pest management; GIS use in field applications; visitor impacts to natural resources and how to deal with them; the people doing the field work and discussions on the value of research in park management; fire management; various wildlife and vegetation issues; international activities; and interpretation of natural resource issues. The editor is always looking for good material and encourages anyone to consider this list of ideas, write a story, and submit it.

Layout and design was another area on readers' minds with nearly a third offering suggestions. Feedback ranged widely and often reflected opposite points of view (i.e., "make more like a newsletter," or "make more like a journal"). Some suggested that the layout should be "opened up," incorporating more white space. However, the vast majority indicated that the materials are now presented in a professional and attractive way and that the publication has improved in this respect.

One additional goal of the survey was to find out how to increase use of the publication by park managers who do not presently read it. Suggestions from the 5% of respondents who do not read it included, choosing articles of immediate interest, focusing on small park issues, increasing synergy between resource managers and other divisions, providing more articles on people and more information on potential grant sources, and distributing it by cc:Mail and over the Internet.

Finally, 31% made general comments about *Park Science,* the most common of which was that they appreciate the publication and do not want to see it lost for whatever reason. Although suggestions for improvement were many, the greatest number of repeat suggestions were for *Park Science* to continue presenting articles of the same sort and diversity as it has been doing. A broad spectrum of articles seems to appeal to readers especially if the material is related to management or real-world applications in the field. This is precisely the *Park Science* niche, for now and for the future.

What does all this effort and information mean? By coincidence or by design, many of the comments gleaned from the reader survey are already being addressed. For example, this issue features articles on butterflies, paleontology, a small park issue (the Lincoln Boyhood National Memorial reforestation story), application of GIS in the field, and a potential "grant" source (the story on construction projects and natural resources), all indicated as areas or high interest by respondents. For those who have Internet access, the publication is available online on the World Wide Web. The editor is also considering a method for distributing the publication via cc:Mail to those who want it delivered this way. In the future, *Park Science* will begin to share personal accounts of resource managers and scientists in the form of interviews, which will improve the immediacy of articles by giving firsthand reports of the application of research to park management. All in all, the survey will help *Park Science* continue to grow in a useful direction over the next several years.

WILDLIFE POLICIES IN THE U.S. NATIONAL PARKS: A KNEE-JERK RESPONSE

A Book Review by Dan Huff

IT'S BEEN JUST ABOUT 10 years since a disgruntled Yellowstone volunteer accused the National Park Service of *Playing God in Yellowstone.* Now, an arguably more credible group of self-appointed NPS critics is using Alston Chase's style to indict the NPS for too much *watching* God in Yellowstone! Could it be that the quid pro quo for "America's favorite bureaucracy," privileged with managing "America's best idea," is the infamous *dual* mission? This apparent dichotomy, "conservation (of park resources) unimpaired for the enjoyment of future generations," serves as a touchstone for some critics of national park policy. But both conservation and visitor use are absolute requisites of the national park idea. Constantly under the coupe of the preservationists and the determinists, we're damned if we do, and damned if we don't. No one said it was going to be easy and NPS Alaska Area Field Director Bob Barbee has, more than once, admonished us to apply for the U.S. Postal Service if we can't handle an honest ration of institutional ambiguity. In fact, one of his very best quotes is "the road to hell is paved with unrocked boats." In that sense, I guess we owe these boatrockers some appropriate gratuity for this contribution to our salvation.

In *Wildlife Policies in the U.S. National Parks,* Utah State University's Fred Wagner, along with Ron Foresta, Bruce Gill, Dale McCullough, Michael Pelton, William Porter, and Hal Salwasser, attempt to make mincemeat of practically everything that is "holy" in NPS natural resource policy. [Note: Salwasser is Regional Forester for the U.S. Forest Service's Northern Region.] The writers summarily discredit the historic and contemporary icons from Starker Leopold's "vignettes of primitive America," to the populist concepts of biodiversity and ecosystem integrity. In doing so, Wagner et al. provide a textbook vivisection of that ambiguity Bob Barbee was talking about a decade or so back. But more than anything else, the treatise implicitly confers why concise, simplistic natural resource management objectives do not work for the National Park Service.

Unfortunately left out is the fact that no national park system units have been established solely for the recreation of pre-Columbian ecosystem conditions or for the preservation of biodiversity–much less the utilitarian objectives of sustainable resource yield. Unlike the Bureau of Land Management and the U.S. Forest Service, the National Park Service has not been burdened by the Congress with all-encompassing, legislated, deterministic natural resource prescriptions. In fact, it has established units with a broad array of both ecumenical and unique "purposes," thereby clearly obviating the utility of a detailed, prescriptive NPS-wide natural resource liturgy. This fact is, obviously, not well understood by the authors.

Wildlife Policies
is available from

Island Press
1718 Connecticut Avenue, N.W.
Suite 300
Washington, D.C. 20009

(202) 232-7933

ipress@igc.apc.org
http://www.islandpress.com

Cloth: $49
(ISBN 1-55963-404-9)

Paper: $26
(ISBN 1-55963-405-7)

In *Policies,* the authors muddle around, sometimes rather aimlessly, in numerous conceptual discussions, citing all the appropriate scientific authorities that support their murky contentions–and most often posing little resolution. [I must admit, I read on with enthusiasm until hand cramps dampened my marginal note-making.] A KEY POINT: Though other parks are mentioned, the obvious focus of the authors' philosophical discord is Yellowstone. If only they understood that Yellowstone, not unlike other national parks, is managed for the suite of purposes explicitly determined by Congress, with NPS-wide policy guidance adopted as appropriate. National Park Service policies *reflect* park-specific policies; they do not proscribe them.

The discussions do a better job of documenting the limitations and ambiguities of contemporary wildlife science than inculpating NPS management decisions

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GREAT PLAINS

Parking Lot Runoff Traced into Wind Cave

In addition to being one of the most extensive cave systems in the world, Wind Cave is home to rare speleothems (formations) and a simple ecosystem that is only recently beginning to be studied. Perched above the cave are a number of surface developments, including roads, houses, maintenance facilities, a visitor center, and a 2.5-acre parking lot.

The parking lot funnels precipitation into just four drains, with one handling almost half of the runoff. These drains direct the flow into an adjacent dry streambed. Most locations in Wind Cave passing beneath this dry streambed are wet, suggesting that the streambed supplies water to the underlying cave. The park was interested in determining whether contaminants from parking lot runoff could be entering the cave in this manner. With funding assistance from the Geologic Resources Division of the Natural Resource Program Center, the park has initiated some special dye traces to study this possibility.

A number of wet locations in the cave were prepared for sampling. Background samples were collected prior to injecting the fluorescent dye and analyzed with a fluorometer, which measures fluorescence. Dye was injected below the largest parking lot drain on July 29,1996. One and eight-tenths liters (1.9 quarts) of Rhodamine WT, a red fluorescent dye commonly used for tracing groundwater, was injected along with 30,000 gallons of water to simulate a 1-inch rainfall.

Dye began arriving at one cave location within 6 hours of injection. Two other sites received dye within 22 hours. By mid-September, an additional two locations had received dye, one location after 16 days, the other after 22 days. Another area showed dye after 73 days.

Dye concentrations peaked at the three initial sites about 3 weeks after injection, and then began to fall off very slowly. Water entering the cave at these sites has remained visibly pink. Concentrations were still rising for the other three cave locations as of November 21. The park estimates that the dye will be entering the cave in measurable quantities for the next 2 years.

The park will be using this information to redesign the parking lot so that ordinary runoff is contained and treated prior to release. Hazardous material spills from ruptured vehicle fuel tanks and other sources could also be contained and removed, further improving water quality within Wind Cave. Commenting about the significance of the experiment in demonstrating the inarguable link between surface runoff and the cave, park Cave Management Specialist Jim Nepstad said, "seeing is believing."

COLUMBIA-CASCADES

Rare Flower Research

The Mt. Mazama collomia is one of the most beautiful and rare wildflowers in Crater Lake National Park, Oregon. Concerns over its vulnerability and long-term viability prompted the National Park Service and the U.S. Forest Service to join with scientists from the University of Idaho to gain information on the ecology of the species. Last summer, scientists worked with volunteers to locate collomia populations and track its population trends and reproductive success.

The research was supported by a generous grant from Canon U.S.A. through the "Expedition Into Parks" program of the National Park Foundation (NPF), an official nonprofit partner of the National Park Service. Dedicated to helping meet the needs of the 367 national park system units, the foundation was chartered by congress in 1967 to channel private resources into the parks. The National Park Foundation awards $2 million in grants each year to support education, visitor services, and volunteer activities that preserve and enhance the parks.

As a result of our studies, we have discovered new populations of collomia and gained new insights into its habitat requirements. We also found that populations of the wildflower in Crater Lake National Park are genetically different from those outside of the park. This means that plants found in the park contain valuable and unique genetic resources not found in other portions of its range.

Once again, Canon U.S.A. has funded continued research and restoration of Mt. Mazama collomia at Crater Lake through a NPF grant. Using the genetic information gained in our initial research, scientists from the University of Idaho will evaluate the physical and biological factors necessary to successfully restore collomia. Eventually, scientists, volunteers, and park staff will come together to establish experimental populations in areas where it once grew in the park.

Restoring Bull Trout at Crater Lake

Bull trout *(Salvelinus confluentus)* is the only native fish known to inhabit Crater Lake National Park today. Within the park, bull trout abundance has been reduced to between 100 and 300 adults; their distribution has been restricted to a 1.9-km reach along Sun Creek. Hybridization and competition with nonnative brook trout *(S. fontinalis)* threatened the Sun Creek bull trout population with extinction. Last year, a generous grant from Target Stores, through the NPF "Expedition Into the Parks" program, supported bull trout research and management, which led to improved management techniques.

From the research, the park learned that standard electroshocking techniques for brook trout removal within the bull trout zone injured bull trout and caused delayed mortality. Resource managers refined their techniques and began using snorkel divers to count bull trout and remove brook trout. The divers counted bull trout by size-age class. When they encountered brook trout, the divers immediately removed them with suction samplers or electroshockers. This technique was successful in reducing brook trout abundance and allowing bull trout to increase in number. However, the technique is not likely to result in the eradication of brook trout, due to the structural complexity of the stream channel.

In future studies, the park will continue to remove brook trout from Sun Creek using the snorkel diver electroshocking technique. They will also monitor bull trout recovery. Removal of brook trout from Lost Creek, where no native fishes are

found, will be conducted with electroshocking and treatments of Antimycin, which proved successful during early phases of the project at Sun Creek. The establishment of a bull trout population in an alternate watershed will serve as a backup in the event that the Sun Creek population becomes extinct or as a source of fish to enhance the restoration of the Sun Creek population.

PACIFIC ISLANDS

Whatever It Takes

Funding and staffing shortages coupled with the continual reorganization of research scientists have made it much more difficult for the National Park Service to accomplish natural resource management projects that protect national parks. In Hawaii, park resource managers and scientists have adopted a cooperative strategy to combine forces and expertise to get the job done in national park areas, and the whole is definitely greater than the sum of the parts. In smaller parks, such as Kalaupapa National Historical Park, developing, organizing, and completing large projects would simply not be possible, given the very small staff and logistical constraints, without the cooperative support of Hawaii Volcanoes and Haleakala National Parks, the University of Hawaii Cooperative Park Studies Unit (CPSU), the Pacific Islands System Support Office, and the Pacific West Field Area. Additional critical support has been shared by the NPS Water Resources Division and the USGS Biological Resources Division (BRD).

Good examples of this cooperative spirit come from recent and ongoing fence exclosure construction projects at Kalaupapa. With the assistance of Dr. Cliff Smith of the CPSU, Lloyd Loope, Art Medeiros, and Chuck Chimera of the Haleakala BRD field station, and the resource management staff of Hawaii Volcanoes, especially Larry Katahira and Howard Hoshide and his crew, the park constructed a fence nearly 3 miles long around a volcanic crater containing rare remnant Hawaiian dryland forest. This forest was being severely degraded by marauding nonnative pigs and a rapidly growing population of alien axis deer. Their efforts, coupled with the park maintenance staff, successfully completed this project in time to save this very special resource, one of the last remaining dryland forests of its type in existence. Newly sprouted seedlings of the native wiliwili tree are being seen in the crater for the first time in years since the exclusion of pigs and deer.

Another fence building project is underway at Kalaupapa, this one designed to protect several federally listed endangered plant species, and a fine example of native coastal strand vegetation. This area is being besieged by more than 500 axis deer nightly, and time is running out for the remaining coastal plants. Again, park partners were there to assist with the vegetation surveys, management recommendations, and administrative support to get the project developed and funded. Pacific Islands SSO and Pacific West Field Area staff, especially Jay Goldsmith and Don Tiernan, helped bring the project to life. Resource managers at Haleakala, led by Ron Nagata, enthusiastically coordinated the materials procurement and construction. The Haleakala fence building crew, led by Ted Rodrigues, are constructing nearly a mile of fencing, often drilling through solid rock to set the posts.

With this kind of cooperative spirit, Hawaiian parks will continue to strive to accomplish more with less. There is no choice–native ecosystems in Hawaiian parks are being rapidly degraded, and parks can not wait.

This illustration depicts the spread of exotic species to Hawaii and some of the resulting natural resource problems. Note the pigs and the exclosure at the far right.

GREAT LAKES

Brook Trout Restoration in Lake Superior

Isle Royale National Park, Michigan, is participating in several research and management activities aimed at the protection and restoration of native *coaster* brook trout. The coaster is a large and colorful form of lake dwelling brook trout that was once abundant in the near shore waters of Lake Superior and parts of the lower Great Lakes. In the early 1800s, the coaster provided a spectacular and cherished fishery, but overfishing and habitat loss reduced populations to the remnant stocks in isolated areas that exist today. Several small populations of coasters at Isle Royale may represent the last viable stocks in U.S. waters (a few small stocks also exist in Ontario).

Park staff have worked closely with the U.S. Fish and Wildlife Service in Ashland, Wisconsin, to develop a consortium of Great Lakes fisheries management agencies and private foundations to research and manage coaster brook trout. Cooperators include state Department of Natural Resources (DNR) agencies, Lake Superior Chippewa Tribal Natural Resource agencies, and Trout Unlimited.

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Initial projects at Isle Royale have focused on collecting data on the size of the wild populations and the biology and life cycle of the coaster brook trout. In addition, DNA analysis is being performed on tissue samples from Isle Royale and the region to determine the genetic relationship of coasters to stream resident brook trout. Preliminary results suggest that existing coaster populations are small and vulnerable and that genetic differences do exist.

Because coasters may spend part of the year in streams, Isle Royale took steps to severely restrict the harvest of brook trout in inland streams beginning in 1994. The park also requested the Michigan DNR to provide additional protection in Lake Superior waters, which led to a larger size limit beginning in 1996.

Finally, Isle Royale has provided logistical support and assistance to cooperators attempting to collect gametes from wild coasters in the park to establish a parent hatchery brood stock. This stock, to be made available to fisheries managers throughout Lake Superior, will be a key element in reintroducing and restoring coaster brook trout to much of its remaining Lake Superior habitat. For further information, contact Jack Oelfke (NPS) at 906-487-9080 or Lee Newman (USFWS) at 715-682-6185.

CHESAPEAKE-ALLEGHENY

Hemlock Ecosystem Studies

The National Park Service and the USGS Biological Resources Division (BRD) have initiated landscape-level studies of hemlock ecosystem biodiversity at Delaware Water Gap National Recreation Area, Pennsylvania and New Jersey, and Shenandoah National Park, Virginia. Previous ecological studies completed at the parks were geographically limited in scope, including only two or three hemlock stands in each park, and did not include stream ecology. In contrast, the new initiative will be geographically extensive, and include as many as 40 stream study sites at Delaware Water Gap.

The initiative has three major goals: (1) determine the extent to which hemlock-dominated forests contribute to landscape-level biodiversity; (2) identify environmental correlates of hemlock occurrence and mortality; and (3) predict and measure the effects of hemlock decline and mortality on ecosystem structure, function, and biodiversity at the two parks.

The NPS has funded a team of three Penn State University researchers to compile existing park biodiversity information and develop standardized sampling protocols for terrestrial vegetation, vertebrates, and invertebrates. The BRD is providing GIS analysis and statistical guidance to ensure effective study design, and they will also conduct stream studies of fish and macroinvertebrates. Caralyn Mahan is the project coordinator (814-863-1904; cgm2@psuvm.psu.edu).

A Different Spin on SSO Support

Three years ago, Chief Scientist John Karish of the Allegheny-Chesapeake System Support Office placed a 4-year term Natural Resource Specialist (wildlife biologist) at the cooperative park studies unit at Penn State. The experiment, unique in the National Park Service, has proven successful in integrating many of the vast resources of Penn State into cluster park resource management projects. The natural resource manager, Michele Batcheller, sees many pluses, along with some minuses, in this alternative arrangement for SSO resource management operations.

From her office in University Park, Pennsylvania, Batcheller first worked on writing a deer management plan-environmental impact statement (EIS) for Gettysburg National Military Park and Eisenhower National Historic Site. Penn State had played an integral role in the research associated with the EIS and had completed a case study that focused on the manner in which participation was obtained during the scoping process. The CPSU had also documented deer movements, habitat use, and park impacts related to the issue. Batcheller had easy access to the CPSU researchers, who helped provide background for the EIS. Their expertise also proved important in clarifying many of the implications of certain data when she wrote the document. Another bonus was being able to confer regularly with Karish, who is also duty stationed there, about the eastern deer issue and other topics. (Karish has effectively administered the regional science and resource management programs for 16 years from the CPSU.) By working from Penn State, she was able to focus on writing without interruptions related to routine park or regional office operations. Although it required much coordination, the EIS was signed by the regional director within 2 years, considered prompt for this kind of task.

Batcheller notes that her isolation from the parks is at times both an asset and a disadvantage. The separate duty station has helped her increase her impartiality in several projects. Even though she interviewed park staff about the deer management issue, Batcheller was able to be more objective when she wrote the EIS. This is because she was supervised by the regional office (now the system support office) rather than the park. However, isolation also challenges her to keep up with common, day-to-day, park operational problems and resource management activities. She comments that this reflects more strongly on her limited experience in the National Park Service, as opposed to the duty station itself. This is Batcheller's first NPS post and she sees the need for a comprehensive orientation to natural resource management in the National Park Service, such as the "Fundamentals" course offered last summer at the Albright Training Center. She regrets that she was unable to attend and has to rely on meetings and networking to provide her this orientation.

Since completing the EIS, Batcheller has broadened her duties. She now provides technical information and advice to cluster parks on wildlife management issues and threatened and endangered species. Surrounded by experts in sociology, forestry, fisheries, and wildlife management, she finds herself acting as a liaison in applying these resources to the best advantage of parks.

Long-billed Marsh Wren Sings Again in the Nation's Capital

By Stephen Syphax

EARLIER IN THIS CENTURY, Long-billed Marsh Wrens flourished in the emergent marshes along the tidal Anacostia River in Washington, D.C. By 1950, practically all of the Anacostia tidal marshes within the District of Columbia were dredged or filled. No doubt, the loss of the emergent marshes, the type of habitat the wren requires, is why it has not been seen or heard in the past 30-40 years in the Kenilworth Marsh (figure 1), part of the Anacostia River wetland.

In a report entitled "Birds of the Washington, D.C., Region (Proceedings of the Biological Society of Washington, March 25, 1929), May Thacher Cooke wrote that Long-billed Marsh Wrens were an "abundant summer resident in the marshes along the Potomac River and Eastern Branch [Anacostia River]". In 1944, Dr. Frances M. Uhler of the U.S. Fish and Wildlife Service authored a report examining bird life in the Anacostia Marshes. In that report, he commented, "under the golden canopy of the flowering wildrice the mid-summer air rings with cheery call of scores of marsh wrens." Most of the marsh land about which Dr. Uhler made that important observation, and many others, was destroyed when it was used as the city dump during the 1960s.

Figure 1. Absent for at least 30 years, the marsh wren staged a comeback last summer at Kenilworth Marsh, a recently restored wetland along the Anacostia River in Washington, D.C.

Restoring the Marsh

In 1992-93, National Capital Parks-East worked with the Washington, D.C. Government, the U.S. Army Corps of Engineers, the Washington Metropolitan Council of Governments, and others, on the restoration of Kenilworth Marsh in northeastern, Washington, D.C. (See the *Park Science* cover article for volume **15(1)**). During that cooperative venture, approximately 32 acres of emergent marsh land were reconstructed in a tidal lagoon that had previously been dominated by exposed mud flats at low tide. Following the reconstruction, a 5-year monitoring program (begun in 1993) was established to look at wildlife utilization, plant biodiversity, and nutrient reduction. If all goes well with the Kenilworth project, the information from the monitoring efforts will be applied toward other marsh reconstruction projects along the Anacostia River (e.g., Kingman Lake–a NPS site downriver of Kenilworth Marsh).

One of the components of the 5-year monitoring program is a breeding bird census (mapping technique for documenting breeding songbirds). Using this technique, year one, two, and three found Red-winged Blackbirds, Common Yellowthroats, and Tree Swallows breeding in the reconstructed marsh. This year (1996) marked the long-awaited return of the Long-billed Marsh Wren to the marshes of the Anacostia River-Kenilworth Marsh!

Natural Resource Specialist Dan Roddy, who has been leading wildlife utilization investigations at Kenilworth Marsh, has been waiting for this day ever since he began the monitoring efforts 4 years ago. Roddy says it has been exciting to see blackbirds, swallows, and yellowthroats attracted once again to the "new marsh", especially knowing the history of the Anacostia River and the many changes it has gone through. However, the Long-billed Marsh Wren might be the best indicator of the success of the reconstruction of Kenilworth Marsh, and real fulfillment would not occur until its return.

This past June, after 4 years of looking, listening, and mapping, Roddy finally heard his first Long-billed Marsh Wren in the Kenilworth Marsh. He observed 3 males establishing territories in sections of the reconstructed marsh. Within 2 weeks of that observation, Roddy saw his first Swamp Sparrow and Willow Flycatcher, also new to the restoration area, demonstrating territorial behavior in the rebuilt marsh.

Although the park continues to have its challenges in the reconstructed Kenilworth Marsh (i.e., exotic plant management), the return of the Long-billed Marsh Wren (and other species) is clearly a positive indicator and may indicate (from a wildlife standpoint) proceeding with current plans for reconstructing another tidal marsh at the nearby Kingman Lake in 1997.

PS

Stephen Syphax is the Resource Management Specialist for National Capital Parks-East. He can be reached at (202) 690-5162.

ECOLOGICAL SOCIETY OF AMERICA MEETING PROVIDES A FORUM FOR DISCUSSING NPS WILDLIFE POLICIES

BY MIKE BRITTEN

LAST AUGUST, I ATTENDED the 81st Annual Combined Meeting of the Ecological Society of America (ESA) in Providence, Rhode Island. ESA was joined in this meeting by the Society for Conservation Biology, the American Society of Naturalists, the Association for Tropical Biology, and the North American Chapter of the Society for Ecological Modeling. It was by far the largest professional meeting I had ever attended with nearly 3,000 registered participants and approximately 2,000 scientific presentations.

I was disappointed to see only about 10 other NPS staff in attendance. While some of the presentations reported on basic research, many described applied research and were very relevant to national park management. The theme of the meeting, "Ecologists and Biologists as Problem Solvers," focused presentation on the utility of applied research. I wonder if the lack of NPS involvement was due to the timing of the meeting and how much was because NPS managers traditionally rank attendance at professional meetings as a low priority.

NPS presentations included: "Potential impacts of recreational use on high-elevation heather populations" by R.M. Rochefort and D.L. Peterson; "An examination of annual grass control methods for use on the Lawrence Memorial Grassland Preserve" by S.T. Gibbons and B. Youtie; and my presentation (along with P.L. Kennedy and S. Ambrose) on "Migration routes and wintering areas of peregrine falcons determined by satellite telemetry." Many other presentations covered work in national parks done by outside researchers. (Also featured was an excellent poster presentation on exotic plant invasion and ecosystem features at Wind Cave National Park in South Dakota by S.M. Ogle and W.A. Reiners. This presentation won the 1995 Braun Award for best student presentation and was excellent. The work examined the habitat associations of various exotic species and developed predictions for the spread of the exotics.)

WILDLIFE POLICIES REVIEWED

A 2-hour panel presentation and discussion on "Wildlife management in the U.S. national park system: the self-regulation theory revisited" was a highlight for NPS participants. Unfortunately, it was held in the evening and only 100 people attended (the daytime presentations averaged much larger audiences even though 15 or more sessions often took place concurrently). The presentation began with a brief introduction by NPS Associate Director, Natural Resource Stewardship and Science, Mike Soukup and was followed by three case studies on the NPS natural regulation policy. Jerry Wright of the National Biological Service, University of Idaho CPSU, summarized the presentations, and then opened the discussion to the audience for a second hour.

Brian Underwood (National Biological Service, SUNY–Syracuse CPSU) described the proliferation of white-tailed deer populations in smaller eastern units of the national park system and resulting conflicts with park neighbors and state wildlife management objectives. NPS managers in these units are operating on a much more local scale than state wildlife managers, which contributes to the problem (caused by habitat alteration and lack of native predators). The second example from Isle Royale National Park, Michigan, was presented by Rolf Peterson of Michigan Technological University. He described the isolated and unstable moose-wolf system in the park that he and others have studied for 38 years. The current wolf population is "genetically challenged" and Peterson predicts extinction within the next few years; he is also very pessimistic about the potential for a natural recolonization of the island (due in part to urbanization on the mainland). Furthermore, Peterson worries that NPS management policies discourage restoration. The final case study was presented by NPS Intermountain Field Area Associate Field Director, Natural Resource Stewardship and Science, Dan Huff who described the history and controversy over natural regulation on the northern range of Yellowstone National Park, Wyoming. NPS management of ungulates on the northern range has included shooting 4,600+ elk (more than half of the herd) in 1962, on one extreme, to the current natural regulation policy (which includes monitoring of ungulate populations, range conditions, and erosion, and more than 25 recent and ongoing studies on the northern range). Huff concluded that it is appropriate for the National Park Service to monitor and study the area as a natural experiment with intervention a possibility if monitoring indicated that irreversible changes are occurring.

The ensuing discussions illustrated the wide range of positions ecologists and wildlife biologists hold on the "natural process" regulation of wildlife populations in parks. At times, the debate became polarized but, overall, some excellent points were raised. Possibly the most important was that NPS managers should consider the scope of their management objectives (usually local) compared to the scope of management objectives of other wildlife and land managers (usually regional) to help understand and avoid conflicts. National Park Service resources can only benefit, in my opinion, when park managers seek to understand the current debate and range of positions in ecological management. The ESA annual meetings are a good place to seek this knowledge.

Mike Britten is a Wildlife Biologist with the NPS Rocky Mountain System Support Office in Denver, (303) 987-6705.

FIRE IN ECOSYSTEM MANAGEMENT: SHIFTING THE PARADIGM FROM SUPPRESSION TO PRESCRIPTION

Figure 1. One of the first, large, long-duration prescribed natural fires to be managed on an interagency basis on both Forest Service and National Park Service lands, the Coyote Fire burned in Yellowstone National Park, Wyoming, last August.

BY TOM ZIMMERMAN

HELD IN BOISE, IDAHO, LAST May, the 20th Tall Timbers Fire Ecology Conference continues to be the single best source of information and debate on wildland fire management in the country. The conference is an outgrowth of the fire ecology series initiated by the Tall Timbers Research Station in 1962. This series began and has continued for 34 years primarily as a determined educational effort. The principal goal has been to create an environment where the results of research and experience can be presented and documented to form a solid foundation for fostering a more intelligent and productive course of wildland fire and resource management. All 19 previous conferences have published proceedings that have markedly increased the state of knowledge regarding wildland fire management. Cosponsors of the conference included the Tall Timbers Research Station, The Nature Conservancy, U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service, and Bureau of Land Management.

Since the first conference in 1962, land managers have shifted their thinking and subsequent management practices from a one-dimensional approach of total fire control to a more multidimensional role of incorporating fire suppression and prescribed fire use into wildland fire management (figure 1). This shift has been largely due to the increased understanding of the role fire plays as a natural process. As our knowledge has increased, we have been able to identify both positive and negative effects of past management practices. While we have succeeded in preserving expansive tracts of forest resources, aggressive and increasingly sophisticated fire suppression techniques have been responsible for such negative effects as changes in stand structure and age-class distributions, and increased accumulations of woody fuels, all of which are combining to cause a large-scale decline in ecosystem health, particularly in the western United States. Considerable effort and attention has been focused on the need to increase prescribed fire applications to combat unhealthy ecological trends, accelerated fuel accumulations, and other effects of prolonged fire exclusion.

e suppression has changed forest stand structure, age-class tributions, and accumulations of fuels to cause a decline in cosystem health, particularly in the western United States.

Given the scope and importance of these ecological concerns, this conference was extremely relevant to today's manager. This year's conference was one of the best attended in the series, with over 300 participants from countries around the world. The agenda included 10 sessions with more than 100 presenters of oral papers, poster papers, and panel discussions. Topics included prescribed fire and risk assessment; prescribed fire in the western and southeastern United States; prescribed fire and avian communities; international perspectives; fire, silviculture, and ecosystem management; and, political and philosophical issues and their limits on pre-

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YELLOWSTONE INVESTIGATES ACCESS AND PROPERTY RIGHTS TO GENETIC RESOURCES

BY BOB LINDSTROM

I RECENTLY ATTENDED A SCIentific conference sponsored by the U.S.D.A. Agricultural Research Service entitled, Global Genetic Resources–Access, Ownership, and Intellectual Property Rights. Held last May at the Beltsville Agricultural Research Center, Maryland, the conference was attended by 300 scientists, lawyers, and intellectual property-rights specialists from around the world. Yellowstone National Park managers have become interested in this topic particularly as it relates to the commercial use and patenting of products from National Park Service research specimens (figure 1). I participated by presenting a poster discussing "Yellowstone Thermophiles and Biotechnology: An Intellectual Property Dilemma," which included industrial applications of 11 Yellowstone specimens.

Figure 1. Replete with organisms adapted to life at high temperatures and often with considerable commercial potential, hot springs, such as Emerald Pool in Yellowstone's Black Sand Basin, have become symbolic of a dilemma to preserve biodiversity in parks while allowing for utilitarian research.

The majority of the conference presentations focused on the loss of biodiversity throughout the world, and what could be done to preserve representative voucher populations. Manipulation of genetic material has been performed by humans since the beginnings of agriculture more than 5,000 years ago. Modern food crops and livestock are crossbred, hybridized, and genetically engineered to meet the dynamic needs of modern society. Much upgrading of our food supply has been accomplished by farmers, fine-tuned by the modern techniques of agricultural research, and marketed in cooperation with the private sector. Such characteristics as semidwarf varieties, fungal rust resistance, and frost hardiness in modern wheat are derived from the biodiversity of developing nations.

Forty percent of modern pharmaceuticals are obtained from plants, most of which are located in the tropical zones of the Third World. Biotechnology has accelerated the manipulation of economically important natural resources by using techniques of tissue cultures, genetic cloning, and overexpression (abnormal production) of gene products. However, many species–valuable in and of themselves, as well as for food crops or medicines–are threatened with extinction due to habitat loss caused by human expansion and development. The loss of in situ (in the field) genetic diversity is a serious problem in the strategic reserves of the human food supply. The agricultural research community's response is to promote *ex situ* (in the laboratory) preservation including seed banks or germplasm production outside the natural habitat of the species. When a war and famine in Ethiopia caused the extinction of a locally important grain, ex-situ seed stock from the U.S. Department of Agriculture was provided to reestablish the drought-tolerant local variety.

Obviously, we also wish to preserve native resources in situ in places like Yellowstone and other parks and reserves around the world. A related issue focused on commercial use of these resources, which was of interest to me, representing the National Park Service. Our primary mission is to preserve park resources, but secondarily, we must provide for public enjoyment of the resources, as long as no harm is done. Research permits are the only allowable means of access to genetic resources and are sanctioned under the provisions of the Code of Federal Regulation (CFR) 36 2.5, "Research Specimens." As global biodiversity is steadily depleted, biosphere reserves such as national parks become increasingly important sources of genetic resources.

Conference participants heard about the 1992 United Nations Convention on Biological Diversity that established an international common law considering genetic resources intellectual property belonging to individual member states. Intellectual property rights (IPR) are simi-

lar to copyright laws in that they protect the owner of these easily copied or pirated resources. The National Biodiversity Institute of Costa Rica (INBio) is leading the pack with respect to IPR, implementing biodiversity preservation by marketing genetic resources to biotechnology companies. Income from biodiversity is used to preserve and protect conservation areas, substituting ecotourism and research for traditional slash and burn agricultural clear-cuts and grazing monocultures.

Yellowstone has often set the precedent in conservation biology, and once again we find ourselves on the forefront of biodiversity preservation. Genetic material from a single Yellowstone microorganism is now the basis of a product that revolutionized molecular biology and generates sales of over 200 million dollars per year: the PCR (Polymerase Chain Reaction). (See Lindstrom's article on PCR in *Park Science*, 16(1):12-13.) The gene, a segment of DNA producing DNA polymerase, was removed (transformed) from the hot spring bacterium *Thermus aquaticus* Yellowstone type-1 (*Taq* YT-1). This research specimen was collected by Thomas Brock in 1967 from the Lower Geyser Basin. He published a description of *Taq* and deposited a copy of the specimen into the American Type Culture Collection (ATCC), a nonprofit repository of microbiological specimens. Due to its tolerance for near-boiling temperatures, the product of this gene, *Taq* DNA polymerase, performs the enzymatic amplification of DNA on an industrial scale providing a "silver bullet" in the study of DNA science.

Kerry Mullis, working for Cetus Corporation, invented PCR in the 1980s when he came up with the idea of using a heat-stable enzyme to produce unlimited copies of "target" DNA. The enzyme chosen to be named in the patent was DNA polymerase from *Taq* YT-1, ATCC# 25104, as deposited by Thomas Brock in 1967, collected under a research permit signed by John Good, Yellowstone Chief Naturalist. Uses of PCR include DNA fingerprinting, disease diagnostics, and forensic analysis. Since PCR can be used to amplify any type of DNA, even fossil DNA can be reproduced. PCR was basis of the Jurassic Park biofiction scenario, where fossil dinosaur DNA preserved in amber was recovered and amplified into living organisms.

The conference poster "Yellowstone Thermophiles and Biotechnology, an Intellectual Property Dilemma" presented information on several other significant industrial applications based on heat-stable enzymes from Yellowstone, also available through the American Type Culture Collection. One organism, *Thermoanaerobacter ethanolicus* is adept at converting cellulose from waste products into ethanol for use as gasohol. A U.S. patent on this organism has been granted to Dr. Jürgen Wiegel under contract with the U.S. Department of Energy. Other organisms that aid in bioleaching of gold ore, removal of paint from military aircraft, and facilitate food processing were mentioned among the many uses of heat-stable industrial enzymes.

The ownership of specimens collected under authorized research and collecting permits is retained by the National Park Service, according to the Code of Federal Regulations. However, when *Taq* YT-1 was named as the source of DNA polymerase in the PCR patent by Cetus Inc., the inventor used our sample for commercial purposes without notification or permission. Since the National Park Service could be viewed as "resting on its laurels" during the patent application process, a case could be made that no proprietary interest exists. On the other hand, no one knew that *Taq*-based PCR would revolutionize the world of DNA science, and that the patent alone would be sold for $300 million. At present, neither the National Park Service nor the American public reaps any intellectual property benefit or royalty from this invaluable genetic resource.

During the conference I had a chance to visit with the president of the American Type Culture Collection. He is interested in working with the National Park Service in establishing an ATCC "Yellowstone Collection." Since there are currently 28 Yellowstone specimens already contained in the ATCC Catalog, 1992 edition, a section on Yellowstone thermophiles would give NPS managers some control over those existing and future deposits of rare thermophiles by including a blanket NPS policy on commercial use of publicly owned resources.

Yellowstone and other national parks are recognized as critical for preservation of biological diversity, for many purposes, including important utilitarian benefits. The potential and existing commercial use of products derived from resources collected from Yellowstone must be evaluated for its impacts, positive and negative, on park visitors and the public who share ownership in the national parks. If funding is ever generated by genetic resources, the money should be used to perpetuate conservation as demonstrated by the Costa Rican model, and not be depended upon for day to day operating expenses.

Income from biodiversity is used to preserve and protect conservation areas, substituting ecotourism and research for traditional slash and burn agricultural clear-cuts and grazing monocultures.

Figure 1. Morrison Formation exposures in the Dillon Pinnacles area of Curecanti National Recreation Area, Colorado.

Late Jurassic Dinosaur Remains from Curecanti National Recreation Area

By Anthony R. Fiorillo, Richard L. Harris, and Cathleen L. May

Curecanti National Recreation Area encompasses the eastern portion of the Black Canyon of the Gunnison, and shares a common boundary with the Black Canyon of the Gunnison National Monument. Both are located in west-central Colorado and are on the Gunnison River, a tributary to the Colorado River. Curecanti contains three dams that comprise the Wayne N. Aspinall Unit of the Upper Colorado River Storage Project. The largest reservoir created by the dams, Blue Mesa Reservoir, is also the largest body of water in Colorado and serves as a major recreational resource for anglers and water recreation enthusiasts.

Geologically, the park is recognized for exposures of rock that date to over 1.7 billion years in age, making them among the oldest in western North America. In addition to these well-recognized resources, the park also contains fossils that have significant scientific and educational value. The most important of these is in the Upper Jurassic Morrison Formation (approximately 150 million years old) in the park (figure 1).

The Morrison Formation of the western United States has produced the vast majority of the Jurassic dinosaurs from North America. However, most of these remains have been derived from only a few major localities (e.g., Dinosaur National Monument, northwestern Colorado, the historically important sites of Como Bluff in southeastern Wyoming and Cañon City in southern Colorado, and others). This important fossil unit, comprised largely of ancient stream, floodplain, and lake deposits, is found at the surface or in the subsurface from Montana to New Mexico and from Oklahoma to Utah. The youngest part of the Morrison Formation is the Brushy Basin Member, which is the source of most of the vertebrate remains from this formation. The age of this rock unit has traditionally been considered to be Late Jurassic. Historically, climatic interpretations for Morrison Formation deposition range from wet to dry and most specialists have suggested a strong seasonality during Morrison times. Given the large geographic extent of the Morrison Formation, many gaps still exist in understanding the distribution of dinosaurs from this interval of time.

Figure 2. Close-up of 3½ sauropod vertebrae, 1½ of whi are partially covered by a plaster jacket. A deer lumbar vertebra is included for scale (arrow). The specimen was encased in a plaster and a burlap jacket to protect it during transport to the preparation lab. A thick layer of tissue paper was placed on the specimen before the plaster and burlap to prevent the plaster from adhering t the fossil bone.

A New Find

In the area surrounding the town of Gunnison, only one significant dinosaur find had been reported previously (Bartleson and Jensen, 1988). A new dinosaur locality was discovered in the Morrison Formation during recent paleontological fieldwork at both Curecanti and Black Canyon of the Gunnison. This site has already yielded the remains of two dinosaur taxa (groups).

The quarry discussed in this report is noteworthy for two reasons. First, this is only the second major dinosaur discovery site in the Morrison Formation between the historically important Cañon City area of the southern Front Range and the Uncompaghre uplift in western Colorado. Second, the discovery of this site in a park not previously recognized for its paleontological resources, emphasizes the point that important management issues may include resources not traditionally recognized within individual parks.

The quarry is at the edge of a lense-shaped, fine- to medium-grained sandstone that thickens to 1.5m (4.9 ft) and is at least 30m (98 ft) in lateral extent along the outcrop exposure. Sedimentary structures within this sandstone suggest a flood event with rapidly decreasing flow velocity.

As mentioned, the remains of two dinosaur taxa have been found at this quarry: an articulated partial sauropod[1] skeleton consisting of several vertebrae (figure 2), ribs, pelvic bones, a femur, fragmentary limb material, and isolated theropod[2] teeth. The sauropod has been referred to the genus *Apatosaurus* (Fiorillo and May, in press) and the initial theropod tooth assigned to the genus *Allosaurus* (Fiorillo and May, in press). Subsequent work has yielded additional teeth that are poorly preserved but are archosaurian, i.e., reptilian, in nature.

Isolated predatory dinosaur teeth are commonly found at sites where articulated or associated dinosaur skeletons also exist (Fiorillo, 1991). These occurrences are typically interpreted as the shed teeth of predators as the predators fed on the carcass.

Sediments Yield Clues

Sediment grain size is an estimator of flow velocity in stream deposits. A good deal of experimental work has been done to provide a means to estimate the relationship between sediments of a given size and the corresponding bones that would have been carried by those stream flows. A large disparity between sediment size and the fossil bone size probably indicates that the fossil bones were not transported to the site as part of the *bedload*[3] of the stream. At the Curecanti dinosaur site a large disparity exists between bone size and grain size; therefore, the bones at the site were not part of the bedload of the current. The articulated nature of the skeleton suggests that the sauropod was transported to the site as a bloated carcass. After being buried, this specimen was probably scavenged by at least one *Allosaurus* and a crocodilian.

When the site was discovered, the global scientific importance, and the regional educational potential, were immediately recognized. This site is located along the shores of the Blue Mesa Reservoir in the national recreation area. Previous destruction of bone material at the site was due to prolonged exposure to the weather and wave action during periods of high lake level. Excavation was deemed the only viable alternative for preserving this resource.

Excavation Ensues

A carefully coordinated excavation project involving the National Park Service, the Dallas Museum of Natural History, the United States Forest Service, and the Academy of Natural Sciences of Philadelphia is currently ongoing. The National Park Service has provided the logistical support and framework for the excavation while the Dallas Museum of Natural History and the Academy of Natural Sciences of Philadelphia have provided the technical expertise for the fine-scale excavation. The first large plaster jacket containing several sauropod vertebrae was removed during the summer of 1995, and subsequent jackets were removed during the summer of 1996. All of these jackets are currently being prepared for detailed study.

Detailed paleontological and sedimentological study of the Morrison Formation of Black Canyon of the Gunnison National Monument and Curecanti Recreation Area have yielded several additional insights into the changing ancient environment of this important rock unit. Results of the other components of this overall study of the Morrison Formation ecosystem will be presented after the data are analyzed.

This discovery in a park not previously recognized for its paleontological resources, emphasizes the point that important management issues may include resources not traditionally recognized within individual parks.

[1]Sauropod refers to quadrupedal, plant-eating saurischian dinosaurs, such as apatosaurus (brontosaurus-type), that have long necks and tails and small heads.

[2]Theropod refers to bipedal, carnivorous saurischian dinosaurs, such as allosaurus, that usually have small forelimbs.

[3]Bedload is that portion of alluvium in a stream that is transported along the streambed and not in suspension in the water column.

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PHOTO BY DON

Figure 2. A question mark butterfly feeds on "bait," a mixture of beer, molasses, and rotting fruit. Baiting is used to inventory shy, woodland species.

a simple questionnaire and sent it to various federal and state parks and wildlife refuges, 463 areas in all. Circulation was subjective, but was based on natural area management relevance (i.e., national historic sites, monuments, etc., were generally omitted as were refuges concerned mostly with fisheries management). This is not to suggest that these areas have no interest in lepidoptera; to the contrary, many smaller parks with limited natural resources can be enhanced by considering butterflies and moths in landscaping designs. The public will also appreciate these enhancements.

A total of 260 parks and refuges responded for an overall 56% return rate. The breakdown is as follows: national parks–64% (80 returns from 122 parks); national wildlife refuges–58% (104 returns from 177 refuges); state parks–46% (76 returns from 164 state parks). The higher percentage of return from the national parks is possibly related to the questionnaire being generated from within the National Park Service. The lower return rate from state parks may relate to their mandate for a more active role in recreation or to fewer biologists (naturalists) on staff than federal agencies. Interestingly, however, 24 (30%) of the responding state parks had active management plans for encouraging or enhancing species of lepidoptera.

We asked whether the natural area had developed a checklist or conducted any inventory of lepidoptera, had exhibits or displays, conducted research or studies, had any threatened or endangered species, or actively managed habitats for any species of butterfly or moth. The response was generally positive: Eighty (30%) areas had (or were working on) an inventory or checklist of lepidoptera. Forty-seven (18%) actively managed parks to encourage, enhance, or restore lepidoptera. Twenty-two (8%) had federal or state threatened or endangered species. Forty-four (16%) had exhibits or displays highlighting lepidoptera and 84 (32%) had studies (past or ongoing) conducted in a park or refuge. Forty-seven (18%) respondents wrote comments on the back of the questionnaire stating an interest in or desire for more information about butterfly and moth species. Seventy-three (28%) sent enclosures with the questionnaire, which consisted of checklists, partial inventories, endangered species studies, and pest management plans.

One respondent stated, "It is encouraging . . . that you are considering . . . a group of wildlife species that has not been at the center of attention in the past."

Discussion

While the response was generally positive, a significant percentage of federal and state parks and refuges appeared to know relatively little about the lepidoptera in their areas. Many parks were concerned about pest species such as gypsy moths; some managed passively for lepidoptera (i.e., as a by-product of prescribed burns, or restoring native prairie grasslands); other parks responded solely to endangered species management mandates for such species as the Karner blue, Schaus' swallowtail, Myrtle's silverspot, or regal fritillary to name a few. Two parks were concerned about illegal collecting. Eighteen areas (especially state parks) reported planting butterfly gardens. While 80 (30%) respondents reported having a checklist or inventory, many were considered partial, having been based on cursory surveys or small collections. Others reported that they were "thinking of doing it," had a survey "in progress," or "anticipate [doing] one."

While some parks had an interest in generating an inventory, they cited lack of funds to initiate one. Perhaps other groups (e.g., butterfly or bird clubs, Audubon Society chapters, The Nature Conservancy) would be able to assist with this undertaking. Donation boxes

Figure 3. A mowing plan that allows weedy edges to grow each year benefits lepidoptera. Purple gerardia is the host plant for the common buckeye butterfly.

placed at visitor centers could bring in additional funds to support such programs.

The many local garden clubs may be willing to help defray expenses and provide volunteers to care for planted areas such as butterfly gardens or open field management zones. Also, state funds may be available, generated by income tax check-offs or special license plate fees set aside for nongame management programs. Volunteers may also be gleaned from contacting national groups such as the North American Butterfly Association, The Xerces Society, or The Lepidopterists' Society.

At Gateway National Recreation Area, volunteers from the New York City Butterfly Club have spent many hours in the field over a 10-year period and provided us with a complete inventory of butterflies (70 species) along with a fair representation of moths (227 species). Moths constitute a much more diverse and difficult-to-identify group, usually outnumbering butterfly species ten times. By this formula we have probably identified less than half the number of species present.

Figure 4. Bumblebee moth (Haemorrhagia axillaris), *a diurnal species, routinely feeds at butterfly bush* (Buddleia).

Figure 5. Woodpiles provide winter habitat for the mourning cloak, questionmark, and several other species that overwinter in the adult life stage. Herptiles, small mammals, and other wildlife also benefit.

Inventorying Lepidoptera

Maintaining open fields or planting patches of milkweeds and other wildflowers will concentrate lepidoptera and reduce the need to go far afield to survey them. Shy, woodland species can be attracted to bait by smearing rotting fruit on bark (figure 2). This works especially well for many species of moths. We use a fancy mixture of fruit, molasses, and stale beer, but an old banana will suffice (why waste beer?). As many species of butterflies are attracted to specific larval host plants, knowledge of these plants should afford a clue to the presence or absence of species. Since many butterfly species are short-lived as adults (2-3 weeks), knowledge of their emergence is paramount, too, as you may have only a brief window of opportunity to see flying individuals. While monarchs, question marks, red admirals and others migrate southward in August and September (especially along coastal beaches), other species such as painted ladies, cloudless sulphurs, and variegated fritillaries are still emigrating northward. This flux of movements provides the opportunity to find additional species in parks during all seasons except winter (in the north).

As for the question relating to past or ongoing studies, 84 parks (32%) responded favorably, although many were in planning, proposal, or "hope to" stages. Some were part of regional or

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state surveys while others were related to tagging or counting monarchs during migration.

Of Money and Moths

In a time of declining budgets, management strategies for butterflies and other insects can be relatively cost effective. Some parks spend many hours maintaining acres of lawn. By allowing some areas to grow into "butterfly gardens" (i.e., fields of wildflowers), managers can save money by mowing once or twice yearly instead of every 2-3 weeks during the growing season. Unmowed areas could be edged (mowed a few feet just off roadways) or sculpted into patterns to give them a "managed" or aesthetic look (figure 3). Mowed trails within these fields would provide easy access for visitors and interpretive programs. Landscaping around buildings with flowering plants will enhance aesthetic appeal while providing a nectar source for butterflies and hummingbirds. We have found the best attractant to be butterfly bush *(Buddleia davidi)* (figure 4). However, it is an exotic and you may want to stick with native species. Many butterfly gardening books are currently available for helping with selections (see references at end).

At Gateway, we have been actively enhancing habitat for lepidoptera for the past 10 years. In many cases it has been as simple as not mowing, mowing less frequently, creatively mowing to leave more weedy edges or patches, planting a few host plant species such as hackberry *(Celtis* spp.) or willows (*Salix* spp.), providing overwintering cover (log piles [figure 5, previous page]) and planting native wildflowers and shrubs as nectar sources. If possible, plantings should be chosen to bloom at various times during the growing season and provide food for larvae. Some knowledge of lepidopteran species present will help guide you in plant selections.

In our experience, managing for lepidoptera has proven to be enjoyable and rewarding for staff, volunteers, and visitors. We hope that this simple questionnaire has spurred some interest in other parks and that we can form a network of communication regarding management concerns and ideas.

Butterflies and moths are ideal subjects for interpretive programs and resource management and landscaping plans.

Obtaining Further Information

If you would like a copy of the questionnaire, a list of references, a butterfly brochure entitled "Butterflies of Jamaica Bay" or have any general questions write: Don Riepe, Gateway National Recreation Area-Wildlife Refuge; Floyd Bennett Field; Brooklyn, NY 11234. By E-mail contact barbara_toborg@nps.gov. For information about butterfly groups and July 4th censuses in your area contact the North American Butterfly Association; 4 Delaware Road; Morristown, NJ 07960; (201) 285-0907. On the Internet you can join a lepidoptera discussion group by sending an e-mail message addressed to: LISTSERV@YALEVM.CIS.YALE.EDU. The message should read: SUBSCRIBE LEPS-L [your name, not in brackets]. You can also access LEPS-L as a newsgroup through sci.bio.entomology.lepidoptera.

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Figure 1. Built amid the Giant Forest in Sequoia National Park, cabins and park housing promote soil compaction, a threat to the behemoths, and must be removed. A new process to award NPS construction funds recognized this project as the highest priority in the national park system. Costing more than $100 million dollars, work of this magnitude will not be entertained in the future unless specifically directed by Congress. However, the evaluation process now considers the benefits of all construction projects to natural resources and targets more affordable proposals as detailed in the following pages.

Natural resources may benefit from new construction evaluation process

By Abby Miller

A NEW LOOK FOR THE NPS line-item construction program suggests that natural resource managers should pay more attention to construction projects as resource management solutions. The NPS line-item construction program (see sidebar on page 21) was reengineered in 1995 and 1996, in part in response to congressional expressions of concern, including cost overruns and a finding that "the priority system is undecipherable." The NPS National Leadership Council (NLC) approved the *Servicewide Development Strategy: The Next Decade* to establish direction for the program, including objectives that every dollar spent on a construction project adds value to the park and the national park system and that every project contributes to resource protection, high quality visitor experience, or improved park operations, including operating in a sustainable and environmentally responsible manner.

In July, the results of reengineering the priority-setting process were implemented for the first time. In the past, the National Park Service relied on the collective wisdom of its senior managers in an informal process to set construction priorities. The new system uses a formal process and a project assessment team to rate and rank projects for review by the development advisory board, a new NLC committee, which in turn develops a priority list for full NLC approval. The assessment team has representatives from each field area, including park, system support office, and field office-level personnel, and representatives of the associate directors for cultural resource stewardship and partnerships, natural resource stewardship and science (the author), administration, and operations. The process was coordinated by Roger Brown, special assistant to the associate director for professional services.

Based on the recommendations of a departmental task force, Associate Director for Professional Services Denis Galvin selected a decision-making system called "choosing by advantages" or CBA, which was developed by a former U.S. Forest Service employee. The objective of the process is to focus on the importance of individual contributions, or specific advantages, of each project, rather than the importance of broad, abstract categories–for example, visitor services are "more important" than resource protection. Paraphrasing an example used in training, CBA focuses on whether a specific difference in weight is more or less important than a specific difference in stability in choosing between two canoes as opposed to whether weight or stability in the abstract is the most important decision factor. To use differences among actual projects requires rating scales to be developed based on the projects at hand (i.e., for each priority-setting effort), rather than generically.

The definition of what constitutes a "construction" project is broader than many believe; it could be a natural resource rehabilitation project.

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Rating Factors Determined

The assessment team met in February 1996 to develop factors to reflect the direction of the development strategy. We first chose four broad objectives–resource protection, visitor services, operations, and "other." The "other" category allowed parks to articulate the advantages of projects that were not captured elsewhere. Each objective has one or more factors–threat elimination, treatment, and support under resource protection; visitor experience and visitor safety under visitor services, etc. The project call, issued last year in April, required information related to these factors, in addition to the 10-238 forms traditionally used for construction projects. Examples of information related to the factors include resource significance as denoted by designations (such as biosphere reserve, world heritage site, and listed threatened or endangered species) and site visitation.

Projects Reviewed

In July, the assessment team met for 6 days to review the projects. After evaluating the greatest benefit (most important advantage, in CBA parlance) provided by any project under each factor, the team judged "eliminating threats" (one of the factors) to the Giant Forest at Sequoia-Kings Canyon National Park by removing facilities from the grove (figure 1, page 19) as the single most important advantage of any project within any of the factors. As a result, this advantage or benefit became the benchmark to create a scoring scale to apply to the advantages of all projects within all of the factors. The Sequoia project received 1,000 points for its advantages in threats elimination and all other advantages were compared to that one and scored.

Although the Sequoia undertaking demonstrates that natural resource projects can be judged highly beneficial under the new system, project submissions with natural resource protection objectives or spin-off benefits were limited in number. This was not true for cultural resource projects since so many cultural resources are facilities themselves and construction projects are integral to their protection.

Figure 2. Open to the elements and subject to vandalism, this fossilized sequoia tree stump at Florissant Fossil Beds National Monument, Colorado, will be protected in the future through construction of a shelter structure.

Water Resources Connection

Most of the projects with benefits to natural resources were projects to reduce or eliminate water pollution. Sewage treatment projects were the most common, although less so than in the last priority-setting process. Upgrades of such plants at Yellowstone and Glacier Bay that eliminated discharges to sensitive waters, and had good information about the discharges and the threats they pose, scored relatively high in the "eliminate threats" factor. Projects to remove septic systems that were leaking near wetlands or significant or sensitive water resources at Cape Cod and Acadia also scored well. Two highly scored projects at Mammoth Cave and Wind Cave dealt with preventing polluted waters from entering cave systems.

Figure 3. Trails within Great Smoky Mountains National Park are degrading. No only is visitor safety a concern, but soil is eroding into streams, threatening aquatic li and vegetation is being trampled. The new construction evaluation process considered these multiple impacts and funded the project, which will repair, rebuild, realign, o relocate 400 miles of trail.

Good, objective data are necessary for a natural resource rehabilitation project to score well

Other project advantages that received points for resource treatment or threat elimination included new or redesigned visitor facilities described as necessary to control impacts to natural resources (figures 2 and 3). Although some natural resource benefits were ascribed to many visitor facilities, those that were judged

to have the most significant resource-related advantages were those described as designed specifically to address a threat to natural resources, particularly camping, waste discharge, and erosion next to water resources. An example is a campground and parking facility designed to prevent indiscriminate and unlimited vehicular camping on beaches at Glen Canyon. Other visitor-related projects receiving high points for spin-off benefits to resources were the replacement of inadequate comfort facilities and the establishment of trails at two Hawaiian parks where "searching for relief" and social trails result in trampling of habitat for endangered plants and bird nesting sites.

Of interest in the "other" category is the advantage of evaluating a project with no direct resource protection value of its own, but that has a bearing on subsequent projects with high resource protection values. In Grand Canyon, a visitor center needed to be relocated first before a new transportation system–that would itself reduce air emissions–could become operational. The desired final outcome necessitated the first project and was judged important in sending a signal to our partners in air clean-up efforts that we are willing to do our part.

Overall Benefits Important

The CBA process requires that projects be ranked not only in order of their individual benefits or advantages, but also in order of their advantages per dollar, i.e., advantage/cost ratio (Note: This is similar to a "cost/benefit" ratio with the important difference that benefits, or advantages, are *not* expressed in dollars). The objective is to get the most value for the national park system from the dollars available to the line-item construction program. For example, the top project could have an "advantage" of 2,000 points worth of benefits (as determined in the scale-making and assigning process previously described) for 2 million dollars, but the same 2 million dollars could buy 4,000 points of benefits by funding several smaller projects. Then decision-makers (the development advisory board and the National Leadership Council) must decide whether several smaller projects further down the benefits list are collectively a better investment for the park system than the single, top-ranked project.

The NLC decided to begin the transition to use of the advantage/cost ratio by using it within three categories of construction projects based on their cost–under $3 million, $3 to $8 million, and $8 to $20 million–to identify priority projects for the fiscal year 1999 program. One-third of the funds allocated to the line-item construction program for that year will be used for projects in each category. This approach will allow a few large-cost projects to be initiated or continued while funding many more medium- and small-cost projects. A new call will be issued late this calendar year to develop priorities for fiscal year 2000 using the CBA-based process with the expectation that the advantage/cost ratio will be more closely followed than it was for fiscal year 1999. Given this increased attention to advantages produced per dollar

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What is Line-item Construction Funding?

By Patty Neubacher

Line-item construction funding is a specific appropriation within the NPS budget that supports major development activities for units of the national park system, including new construction and repair or rehabilitation of existing infrastructure. A "line-item program" means that there is a line item in the budget justification for each construction project requested. Funds appropriated for a specific line-item project must be spent exclusively on that project.

Line-item funds are *no-year* funds, available until expended. The need for no-year funds essentially defines the type of work the construction appropriation represents–i.e., the work is of a size and complexity that requires a number of years to complete, making the use of annually expiring funds impractical. The work is characterized by long-term planning followed by construction that could extend over several fiscal years.

How are funds requested?

Funds for line-item construction projects are requested using a standard NPS form 10-238 and any supporting documentation. The form is used to describe the project and provide a justification and cost estimate for the proposed work. Many parks and field areas are now using an electronic database version of the 10-238 program to develop and store information on all unfunded project needs.

The budget formulation process for a line-item construction project is a *bottom-up* process. That is, parks start the process by originating the 10-238 documents. They develop 10-238s primarily using planning documents as a guide. All requests must be in conformance with policy and planning documents, including general management plans, statements for management, development concept plans, interpretive prospectuses, and servicewide guidelines and directives.

How are priorities established?

Once the 10-238 has been approved by the park superintendent, a park priority number is assigned. The document is forwarded to the field director for review, approval, and assignment of a field area priority number.

Field directors typically assign priorities with the assistance of a priority committee. Membership on a priority committee varies by field area but is characteristically organized with park, cluster, field office, and technical representatives. Once field area priorities are established, the projects are submitted, via the Associate Director, Professional Services, to the project assessment team for ranking.

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Assessing the Condition of Riparian-Wetland Areas

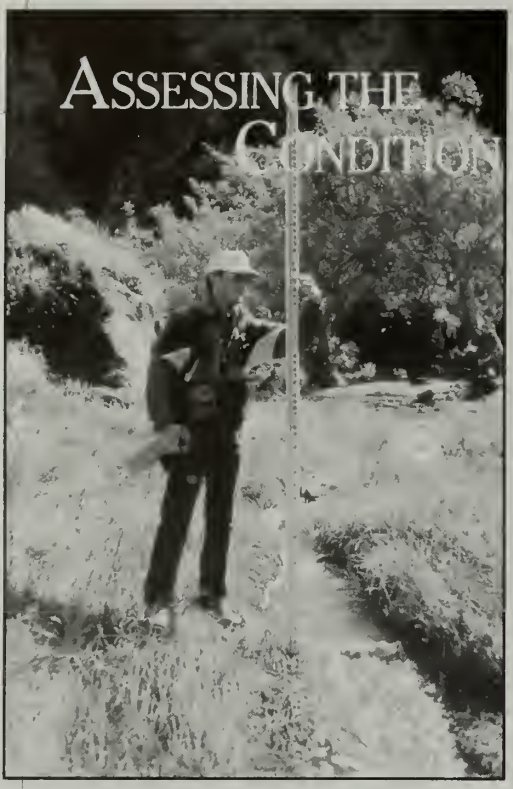

Figure 1. Cañada Lobos (Channel Islands National Park, California), located within a cattle exclosure, is a properly functioning wetland. The area features diverse and vigorous plant life that protects the stream banks from erosion and improves water quality.

By Gary Rosenlieb, Joel Wagner, and Bill Jackson

The many benefits of maintaining healthy riparian-wetland systems have been well documented in the natural resources literature. Healthy riparian systems improve water quality primarily by decreasing sediment transport, rebuilding and replenishing floodplains, reducing streambank erosion, retaining soil moisture, and supporting the development of diverse flora and fauna communities. Riparian areas are also magnets for many competing uses that can conflict with resource protection. Domestic livestock congregate in riparian-wetland areas for forage, water, and shade; streams are dammed or diverted for various uses; and visitors utilize riparian areas for fishing, hiking, boating, and other recreational pursuits.

In order to properly manage these important resources, park managers must be able to assess riparian-wetland conditions and take steps to resolve any problems. All too often, however, when asked to assess the condition or overall health of our riparian areas, we natural resource managers are at a loss to respond with much more than, "they look OK to me," or, "they look terrible," without a strong rationale for either conclusion. Given our critical role in the conservation of soil, water, vegetation, and wildlife resources, it is essential that we have proper tools to evaluate the health of the riparian systems under our stewardship, especially when multiple competing uses are present.

The Process

A riparian-wetland assessment tool developed recently by the Bureau of Land Management (BLM) was used by the Water Resources Division staff of the Natural Resource Program Center in 1995 to evaluate riparian conditions in two national parks. This method, called the "Process for Assessing Proper Functioning Condition," is keyed to an interdisciplinary team assessment of riparian area "functionality" rather than a costly, intensive data collection effort. The goal is rapid assessment, which can be applied over large areas relatively quickly. It may be used as a "triage method" that can help separate areas that are functioning well from those in need of more intensive evaluation and management.

The *functioning condition* of a riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A healthy or stable riparian-wetland area is in dynamic equilibrium with its streamflow forces and channel processes. In a healthy system, the channel adjusts in slope and form to handle larger runoff events with limited perturbation of the channel and associated riparian-wetland plant communities.

Important to note is that evaluation of functional condition is not simply an assessment of the ecological status or seral stage of the vegetation community. Rather, evaluation is based upon the concept that in order to manage for such things as potential natural vegetative communities, the basic elements of physical habitat must first be in place and functioning properly. For example, a system recovering from a recent fire can be in an early successional stage but it may still be in properly functioning condition.

Based on assessments of hydrologic, vegetative, and erosional elements (see the checklist in table 1) of the riparian area, the method assigns one of the following functionality ratings to a riparian-wetland area:

Proper Functioning Condition

Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris are present to: (1) dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; (2) filter sediment, capture bedload (see the definition for *bedload* at the bottom of the middle column on page 10), and aid floodplain development; (3) improve floodwater retention and groundwater recharge; (4) develop root masses that stabilize stream banks against cutting action; (5) develop diverse ponding and channel characteristics to provide habitat and the water depths, durations temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and (6) support greater biodiversity. Similar factors are assessed when evaluating *lentic* (standing water) wetland areas as explained in USDI-Bureau of Land Management (1994).

Functional-At Risk

These riparian-wetland areas are in functional condition, but an existing soil, water, or vegetation attribute makes them susceptible to degradation. For example, a stream reach whose upper watershed is being overgrazed may have the attributes of a properly functioning system, but it may be poised to suffer severe erosion in a future large storm due to artificially increased runoff upstream.

Nonfunctional

Riparian-wetland areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows and thus are not reducing erosion, improving water quality, etc., as already described, are nonfunctional. The absence of certain physical attributes such as a floodplain where one should exist are indicators of nonfunctioning conditions.

Riparian Functionality in the National Parks

In 1995, staff from the Water Resources Division, in cooperation with the BLM and staffs of Channel Islands National Park, California, and Great Basin National Park, Nevada, used the process for assessing proper functioning condition to evaluate the functionality of riparian areas on Santa Rosa Island in Channel Islands and the Lehman, Snake, and Baker Creek drainages in Great Basin. These parks provided an ideal testing ground for the assessment process in that they represent differing physiographic and climatic provinces (Southern California coastal zone at Santa Rosa Island vs. the montaine basin-range province at Great Basin). In addition, both parks are grazed by domestic cattle. Santa Rosa Island is subject to continuous year-long grazing, while a seasonal rest-rotation grazing system is employed at Great Basin. Riparian functionality in both parks was assessed by an interdisciplinary team consisting of a hydrologist-geomorphologist, botanist, water quality specialist, wetland scientist, and a range management specialist. Examples of "properly functioning condition," "functional-at risk," and "nonfunctional" riparian areas in these parks follow.

Table 1. Hydrologic, vegetative, and erosional attributes that are evaluated for riparian-wetland functionality

Hydrologic

- Floodplain inundated in "relatively frequent" events (1-3 years)
- Active-stable beaver dams
- Sinuosity, width-depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
- Riparian zone is widening
- Upland watershed not contributing to riparian degradation

Vegetative

- Diverse age structure of vegetation
- Diverse composition of vegetation
- Species present indicate maintenance of riparian soil moisture characteristics
- Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events
- Riparian plants exhibit high vigor
- Adequate vegetative cover present to protect banks and dissipate energy during high flows
- Plant communities in the riparian area are an adequate source of coarse and large woody debris

Erosion Deposition

- Floodplain and channel characteristics (i.e., rocks, coarse and large woody debris) adequate to dissipate energy
- Point bars are revegetating
- Lateral stream movement is associated with natural sinuosity
- System is vertically stable
- Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Santa Rosa Island-Cañada Lobos (Wolf Canyon)

Diagnosis—Properly Functioning Condition

Cañada Lobos (figure 1), located within a cattle exclosure, represents a riparian-wetland area that was rated to be in "proper functioning condition" by the interdisciplinary team. The riparian area contains a diverse and vigorous herbaceous and woody vegetative community that protects the banks by dissipating stream energy associated with flood flows, thereby reducing erosion and improving water quality. The herbaceous plant community, consisting primarily of Mexican rush and saltgrass, has developed root masses that have stabilized the stream vertically and horizontally, filtered sediment, and captured and retained bedloads that aid floodplain development. The process has created diverse channel characteristics and promotes greater biodiversity.

Santa Rosa Island—Windmill Canyon

Diagnosis—Functional-At Risk

This segment of Windmill Canyon (figure 2, page 24) is grazed by horses but not cattle. The establishment of willow provides the capability to dissipate some stream energies and trap sediment that aids in floodplain development and improves floodwater retention. However, in spite of the presence of some attributes of functionality, this segment was rated as "functional-at risk" because certain vegetative and hydrologic attributes make it susceptible to degradation. For example, herbaceous bank cover is completely lacking, thus making the bank more susceptible to erosion and lateral cutting. The trans-

Continued on page 24

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port of large quantities of bed and suspended sediment loads to the segment from unprotected upper watersheds also prevents this stream segment from obtaining full proper functionality.

Figure 2. Windmill Canyon (Channel Islands) is a functional-at risk stream. Vegetative bank cover is lacking, but the presence of willows allows for some ability to dissipate stream energies.

Santa Rosa Island—Old Ranch Canyon

Diagnosis—Nonfunctional

Old Ranch Canyon (figure 3), subject to continuous year-long cattle grazing, is a "nonfunctional" riparian-wetland area. Neither adequate vegetation nor appropriate landform is present to dissipate stream energies associated with high flows. During floods, the stream channel migrates, erosion continues, sediment is not filtered, water quality is altered, and floodwater retention and groundwater recharge are limited. The channel is not providing ponding or channel characteristics that provide habitat conditions necessary for enhancing biodiversity.

Great Basin National Park—Lower Snake Creek

Diagnosis—Functional-At Risk

Karst geology, hydrology, and diversion by humans are important features that dictate the "functional-at risk" rating for this riparian reach. Prior to diversion, upper Snake Creek lost almost all of its flow to the karstic aquifer that underlies downstream portions of the creek. In order to "harvest" additional water from the drainage, local irrigators constructed a pipeline to divert water from upper Snake Creek, bypass the karst area, and then release it to lower Snake Creek for transport to their land. The diversion has most likely impacted the lower reach by increasing flood flows in a channel that had evolved in response to smaller flows. Figure 4 shows one of several headcuts observed in lower Snake Creek that, though temporarily stabilized by woody debris, could continue cutting in response to large flows. The headcuts are lowering the base level of the channel by 2-3 feet in some areas. As a result, woody and herbaceous riparian-wetland vegetation in these segments are in a downward trend.

Figure 3. Old Ranch Canyon (Channel Islands) is a nonfunctional riparian-wetland area. It has neither adequate vegetation nor appropriate landform to dissipate stream energies.

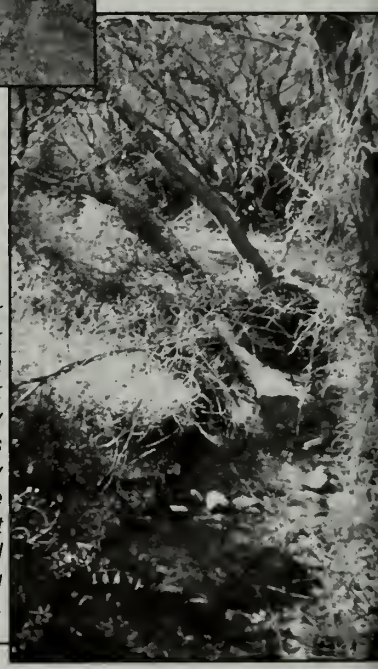

Figure 4. Lower Snake Creek (Great Basin) is a functional-at risk stream. Woody debris has temporarily stabilized the stream, but erosion is still possible during large flows.

Conclusions

The process for assessing proper functioning condition is an assessment tool that can be used to rapidly evaluate and categorize the functional condition of riparian-wetland areas. When applied by an experienced interdisciplinary team, riparian areas that are in danger of losing functionality can be identified and management prescriptions can be developed and applied. While the assessment process is a valuable tool in the hands of an experienced interdisciplinary team, it may not be suitable for all riparian areas. This is a qualitative process that has been developed from more strenuous quantitative monitoring procedures that are documented in the BLM Ecological Site Inventory (ESI) methodology. In some cases, the more expensive and time consuming ESI procedure must be used to determine riparian functionality.

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TOGRAPH BY TOM YARRISH

Figure 1. Named for the site of its origin, Mt. Vision, the Vision Wildfire was the largest in Point Reyes National Seashore in the last 60 years. The use of GIS (geographic information systems), however, aided both the fire suppression and natural resource rehabilitation efforts.

INTERACTIVE APPLICATION OF GIS DURING THE VISION WILDFIRE AT POINT REYES NATIONAL SEASHORE

BY SARAH G. ALLEN, DAVID KEHRLEIN, DAVID SHREVE, AND RICHARD KRAUSE

THE MOST DEVASTATING wildfire to burn in Point Reyes National Seashore, California, in over 60 years spread rapidly through the park in the fall of 1995 (figure 1). Over 12 days, the fire burned more than 12,000 acres and destroyed 45 homes on state, federal, and private lands. At the height of the fire suppression campaign, 2,164 personnel, including 74 hand crews, 27 bulldozers, 7 air tankers, 7 helicopters, and 196 fire engines, were involved. Named the Vision Fire after the site where the fire was ignited in an illegal campground (Mt. Vision), the lessons learned from this incident also provided tremendous insights into fire management.

One lesson learned was the usefulness of geographic information systems (GIS) and global positioning systems (GPS) in the fire suppression and rehabilitation efforts. This is the story of how a team of GIS specialists and resource managers applied GIS during a wildfire in a wildland-urban interface, and what we recommend to better prepare for the use of GIS in such an emergency.

BAER TEAM ASSESSES IMPACTS

Shortly after the fire began, the Point Reyes Superintendent called in the Burn Area Rehabilitation Team (BAER team), a multiagency group with expertise in plants, animals, soils, water resources, cultural resources, structures, and roads and trails. (See the Highlights story on the BAER team in *Park Science* 16(1):6). Their primary task was to document both the fire effects and fire suppression impacts on park resources. Within 2 weeks, with the aid of GIS, this team was able to make a comprehensive assessment and recommend actions to the National Park Service for short- and long-term restoration and rehabilitation.

Plant communities within the fire area are diverse and include marshland, coastal prairie, coastal grasslands, riparian, coastal dune, northern coastal scrub, bishop pine forest, and Douglas-fir forest. Each community has associated species that are unique to California and the world. Within the burn perimeter, many species of plants (23), mammals (8), birds (24), insects (8), amphibians (4), reptiles (2) and fish (4) are sensitive or endemic to the park. Several species have special recognition under the U.S. Endangered Species Act and the California Endangered Species Act.

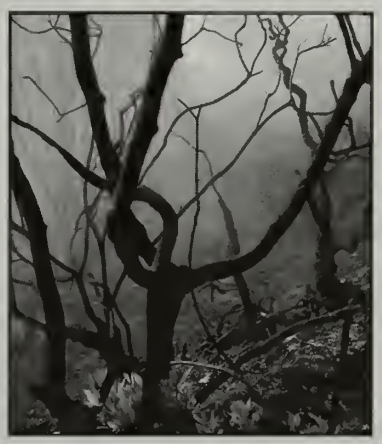

Figure 2. The BAER team noted the variability of blaze intensities. Where it was hottest, the fire will retard vegetation recovery and promote erosion, two processes that the park will monitor.

The assessment noted extraordinary changes in the physical, chemical, and biological status of park resources. A number of plant communities and associations burned at very high to severe intensities (figure 2), influencing recovery of the ecosystems. These included Bishop pine forests, coastal scrub, northern coastal prairie, and some Douglas-fir forests. Many of these communities occur on steep slopes exceeding 54 degrees. Soil associations within the burn are highly prone to erosion and repel water following moderate to intense fire. Erosion potential is also very high due to locally high rainfall (14 inches per month).

Fire suppression actions associated with containing and controlling the Vision Fire relied heavily upon direct and indirect

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mechanized bulldozer fire line construction. Bulldozer line construction totaling 23 miles occurred primarily within the wilderness; much of it occurred in the upper reaches of watersheds with impacts to existing trails with direct line construction on extremely steep and unstable slopes. In some areas, the fire lines traversed locations of known noxious weeds and increased the potential for spread of these species. Down slope are numerous watersheds, riparian areas, wetlands and estuaries.

Both the fire and suppression activities exposed many cultural resources; both Native American midden sites and historical ranch dump sites dating back to the turn of the century were uncovered. In addition to the 45 structures destroyed by the fire, tens of telephone poles were damaged and an estimated 2,000 hazardous trees posed a risk to park visitors along roads and trails.

As part of the fire recovery effort, the park initiated several studies to evaluate fire and fire suppression effects on the ecological integrity of communities within and adjacent to the burn area. GIS-GPS will help to monitor treatments and affected resources to determine the efficacy of measures taken to mitigate suppression and rehabilitation actions.

GIS Support Arrives

During and immediately following the fire, the park used GIS and GPS to map and monitor the daily and hourly spread of the fire (figures 3 and 4), measure fire suppression actions, assess damage to natural resources, and evaluate damage to adjacent homes in the wildland-urban interface. Technicians created numerous GIS-GPS data layers, including those for fire intensity, bulldozer line locations, and fire perimeter over time. These data layers were integrated in a form that enabled the park to measure, monitor, and map several data themes simultaneously, providing a more comprehensive understanding of the effects of the fire.

These tasks were possible only through the efforts of many personnel and the generous support of state and federal agencies, private organizations, and vendors. Point Reyes National Seashore, like many parks, had a fledgling GIS program with some equipment and was in the process of upgrading and moving its GIS resources to new quarters when the fire occurred. Fortunately, within 12 hours of ignition, the California Office of Emergency Services dispatched a strike team of GIS specialists to aid in the fire analysis. This self-contained team included four GIS specialists and computer hardware and software capable of assessing the spread of the fire. Upon this foundation, a fully operational GIS lab was in place within 2 days of fire ignition.

The GIS lab extended to three offices, and cables snaked through hallways networking computer hardware between GIS platforms. At the height of the operation, hardware consisted of two Sun Microsystems UNIX-based workstations (with Arc/Info and ArcView software), two DOS-based personal computers (one with PC ARC/INFO and the other with MapInfo), two laptop computers, two Hewlett-Packard HP650C DesignJet printers, a digitizer, and various smaller printers. During the fire, the GIS team consumed five rolls of plotter paper, four color cartridges, several reams of paper and tens of diskettes.

Numerous people with computer systems administration skills, including GIS and GPS experience, rotated through the GIS lab, which helped keep the operation running smoothly, 24 hours a day. Individuals came from the National Park Service (field area office and Golden Gate National Recreation Area); the University of California, Berkeley; the California State Lands Commission; and the Burn Area Emergency Rehabilitation (BAER) team. Additionally, one person acted as liaison between the GIS lab and the outside world, helping to interpret the needs of the "customers" and what the lab could produce. The language of users and producers often necessitated translation because many disciplines (e.g., geology, hydrology, ecology, computer science) were combined into the GIS.

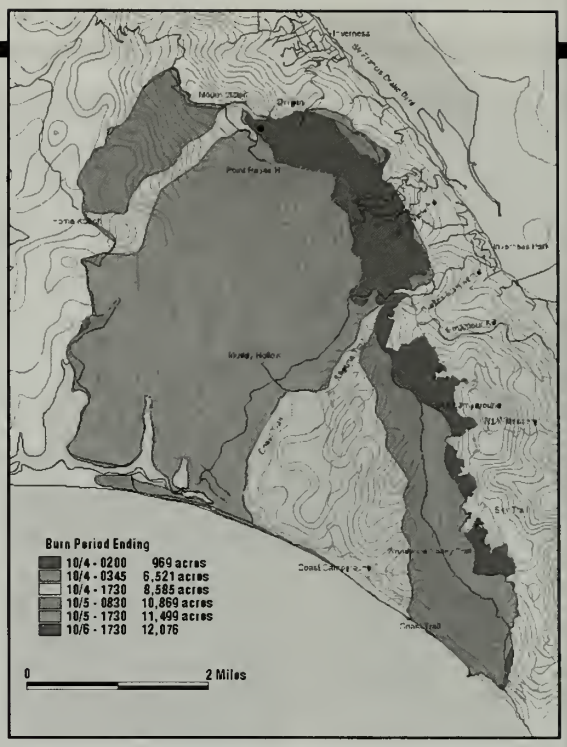
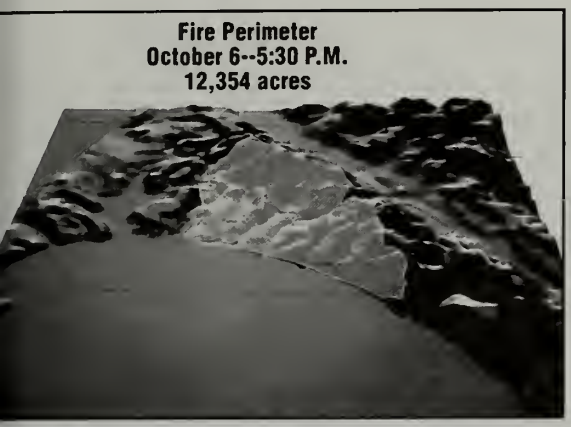


Figure 3. Through the use of GIS, staff were able to produce detailed fire perimeter maps that not only aided fire suppression efforts, but also documented resource damage for follow-up rehabilitation.

GIS Products

Map "users" ultimately defined the products we generated; however, the demand for and the sophistication of products evolved over time as users perceived the value and capability of the GIS output. Users included decision makers from all disciplines, fire fighters, public information officers, the BAER team, researchers from universities, and the general public.

Initially, the most critical information required from the GIS lab was the fire perimeter. Twice per day, a helicopter equipped with a GPS unit flew the fire perimeter, and a map was promptly produced for the fire fighters. Another critical data layer was the location and condition of structures destroyed by the fire. The California Department of Forestry, Marin County Fire Department, and NPS personnel surveyed homes in the burn area with various GPS unit models (Trimble Navigation, Light ProXL, and Basic Plus) and collected data on the condition and location of structures. Within 4 days of fire ignition, and while the fire was still burning, these data were converted to a GIS data layer and overlaid with a county parcel map to identify the owners of the structures.



ure 4. The GIS team produced a multivariable, nulated, 3-dimenional map, which indicated that ography is important in defining high intensity burn eas. The hottest zones occurred along ridges where nds were highest.

Data were also gathered using GPS on location of hand and bulldozer fire lines, roads, trails, fire suppression effects, noxious weeds, vegetation plots, photo points, and survey points. GIS was then used for mapping, measuring, and monitoring post-fire analysis of burn effects and rehabilitation prescriptions. Examples of preliminary products generated include generalized location and identification of high to moderate burn intensity zones, of fire suppression measures, of cultural resources in relation to bulldozer lines, and of threatened and endangered species in relation to fire suppression actions. As users perceived the ability of GIS to measure and calculate information, they requested reports on acreages, linear distances, and other parameters.

Several data layers already existed in the park GIS, including soils, digital line graphs (DLGs), digital elevation models (DEMs), and a few U.S. Geological Survey digital orthophoto quads (maps produced from aerial photographs that are corrected for parallax and referenced to control points on the ground); however, a crucial missing data layer was a digital vegetation map. A recent Landsat Thematic Mapper (TM) image was available but it was not ground-truthed and could only be used for general reference. Instead, we created a vegetation map using the USDA Natural Resources Conservation Service digital soils map and correlating the information with the associated vegetation types. This proved surprisingly useful for some of the analyses with some adjustment based on spot checking with aerial photos.

As time allowed, we also added more precise and inclusive information to the existing GIS databases. Examples include measuring more precisely the extent and location of potential soil erosion sites, monitoring the spread of noxious weeds and the recovery of vegetation communities, and locating roads and trails with greater accuracy (the USGS DLGs were inaccurate). These data were crucial in assessing fire effects and guiding rehabilitation and mitigation prescriptions.

To speed up production of maps and to assure conformity in style, we brought in specially tailored, preexisting programs (AML–the programming language for Arc/Info) and developed new ones. At one point, we plotted a California Department of Fish and Game Heritage Program species list of concern from the State Lands Commission in Sacramento via the Internet on a plotter at Point Reyes.

Making Improvements

The fire teams faced several challenges when using GIS that cost precious time. With just a little preplanning, many of these issues could be eliminated. For example, GIS support was not formally linked to the incident command structure; consequently, the GIS team responded to many nonprioritized requests. A simple solution would be to place the GIS function in the incident command structure. Products should be prioritized with those that support fire operations being highest priority.

Many problems specific to GIS occurred. Differences in map projections and data scales created incompatibilities. Data were often incomplete and sometimes out of date or of poor quality, and file naming conventions and data categories needed to be standardized. Unfortunately, we lost the opportunity to track the fire history because maps drawn by firefighters were lost as the GIS lab was gearing up. Improvements would include adopting a map projection standard and maintaining the software to convert nonstandard projections. A metadata form might also be developed and maintained during the fire to aid in standardized data input. The simple act of providing a bin for early map storage might prevent future map losses. One set of hard copy maps should also be kept in a secure place. We could have devoted more time to the GIS products themselves if we had prepackaged GPS data dictionaries for field data collection. Likewise, prepackaging software that would facilitate GIS products to be made from maps of several sizes would have helped. Furthermore, this software needs to transfer easily across computer platforms.

Not only was translation between platforms poor, but hard disc space was also inadequate. Permission to access files on the UNIX workstations also caused trouble. An experienced system administrator was always needed but not always present. Despite lacking the space for bulky computer systems, digitizers, and plotters, we still could have used more computers. We had no method to track computer system performance problems for follow up. A virus, brought in a laptop computer, plagued systems for a couple of days before being identified and removed. Scanning for viruses as new equipment is brought in would be a good idea as is providing a log book to document computer problems. Establishing solid vendor contacts would also help so that problem solving can occur swiftly when a computer disaster occurs. Maintaining a list of computer trained contacts could help address problems that occur in the

The park used GIS and GPS to map and monitor the spread of the fire, measure fire suppression actions, assess damage to natural resources, and evaluate damage to homes.

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Lincoln Boyhood National Memorial Reforests

Figure 1. The Drackett grant provided funds for the reforestation project, which began in December 1992 with 100 trees.

By Don F. Adams

IN SEPTEMBER 1992, LINCOLN Boyhood National Memorial, Indiana, received a $40,000 grant through the National Park Foundation from the Drackett Company (manufacturers of O'Cedar, Drano, Vanish products) to reforest 0.025 ha (2.5 acres) of land adjacent to the Memorial Visitor Center and parking plaza. On May 6, 1993, following the presentation of the check to Superintendent Paul Guraedy by former NPS Director James Ridenour, the honored guests, the Drackett Company, National Park Foundation, and NPS representatives visited the site to turn spadefuls of earth around a 4.6m-tall (15 ft) ash tree. These actions launched the reforestation project, made known the Foundation's support, and recognized the Drackett Company's generosity and their "Great American Clean Up Campaign." (Note: S.C. Johnson Co. absorbed the Drackett Company in 1993-1994.)

Planting Begins

Managers opted to first plant 100 landscape-size native hardwoods averaging 2.76m tall (8 ft) in the south meadow east of the visitor center (figure 1). A local nursery accomplished this in December 1993 for $6,000. The bundled-up crew of two men and two women planted, staked, and wrapped 20 black oaks, 30 white oaks, and 10 each, red oaks, shagbark hickories, dogwoods, and white ash–all in one day. Our only concern was that a few trees seemed to march in straight lines instead of appearing randomly placed; the trees were spaced 3m (10ft) apart. (We planned this spacing in order to freely maneuver a pickup truck, water truck, and ATV.) On the next round of planting in April 1995, we added 30 more trees to the south meadow, plus a contractor replaced 14 trees that had died.

Trees that died? Yes! Although only five trees failed to leaf out in the spring, the summer of '94 was uncommonly hot and dry. Rainfall was six inches below normal. Despite fire hose waterings by park staff and Youth Conservation Corps (that included a few great water fights) we lost nine more trees due to temperatures reaching the high 90s. Apparently, we also lost some to creatures that we didn't know about as we found inch-long, grayish white worms inside the dogwood tree trunks. We were lucky in one respect: the brazen, grazin' white-tailed deer left our trees alone–this time.

Another challenge in 1994 was the attempted takeover of the south meadow by weeds, grasses, and thousands of thorny black locust sprouts. So we mowed the meadow in late summer and successfully applied Round Up™ herbicide around the bases of all the new trees. That year, a remnant highway and abandoned septic system east of the visitor center were also removed and the area landscaped for about $10,000.

In the spring of 1995, another landscaping company planted 200 white oaks, red oaks, ash, shagbark hickory, black cherry, and black walnuts in the north meadow. Interestingly, on recommendation of the landscaper, they planted these young trees experimentally in "family groups," or clusters, with the same spacing, as opposed to the totally random planting in the south meadow. A maintenance crew mowed the meadows and used Round Up™ herbicide to control weeds and grasses around the trees. Monitoring found that our new dogwood trees planted in 1993 were infested with borer insects, but no action was taken to purchase and apply the recommended Dursban (insecticide) at that time. (A tree care expert informed us that injection fertilization of the trees in spring and fall would likely reduce or eliminate the need for Dursban.) Impressed with this reasoning, we plan to initiate a periodic fertilization program.

For 1996, we awarded the third planting contract for $6,000. The contract called for setting 100 2.16m-tall (7ft) native hardwoods in the old roadbed east of the visitor center parking plaza, and replacing about 34 trees that had died in the adjoining meadows.

Problems included delays in receiving the trees, heavy rains and soft ground, which delayed planting by 2 weeks and required the planting crew to use wheelbarrows to transport trees to the site. (The contractor grumbled, but we held firm.) A crew of four, as was customary with this company, hand dug the holes for the trees, which by now were in full leaf. We experienced another delay of 2 weeks getting the replacement trees planted in the meadows, apparently because of other commitments by the company. After several calls, the crew finally returned and planted the trees, which had been "parked" in their ball and burlap "diapers" and kept watered down by park staff. (This time we grumbled–loudly!) Following more calls, the crew returned and fin-

ished the job by mulching and staking the replacement trees.) To date, 18 of the newly planted landscape trees have died and have been replaced by the contractor. Weekend watering, however, is benefitting all the trees and, as landscapers like to say, "may bring the rest out."

ure 2. Trees in the North Meadow are doing well and are ginning to look like a fine young forest.

Looking Back

We did not realize the awesome responsibility of nurturing 100 trees initially, then 200 more, and finally 450 landscape-size natives when we received the munificent $40,000 grant. We also did not comprehend that baby oaks become mighty and need water, extra nutrients, and lots of care. For example, summer rainfall in southern Indiana seldom furnishes an inch of rain a week. Although we water the trees, we have found it difficult to keep up with the task as staff has melted away through the years. The YCC (Youth Conservation Corps) is gone. VIPs (Volunteers-in-Parks) are difficult to find. The maintenance staff is down. Resource managers are willing, but are becoming older and slower and creaky in the joints.

Fortunately, enough money remains in the Drackett account to contract fertilizing, pesticide care, and tree replacements for the next 2 years–time needed for young oaks, ashes, hickories, dogwoods, and walnuts to establish themselves, spread their roots, and fight off insects.

The deer returned. Oh yes! Young bucks with blazing hormones and itchy antlers rubbed raw many of our healthiest landscape trees a year ago. All survived–bucks and trees–but the superintendent had all she could do to restrain the resource management ranger from charging the deer with trespass and high velocity rock salt.

In summary, despite all kinds of problems, the landscape trees planted in two meadows and the old roadbed over the past 4 years are beginning to look like a fine young forest (figure 2). With care, we can be proud of our contribution to the life of Lincoln Boyhood National Memorial, as we watch our youngsters start to grow big and strong for future generations. After all, it was in this place 170 years ago that two mothers and a father watched their youngster grow big and strong, and wondered –would he get on?

PS

e did not realize the awesome responsibility of nurturing 100 trees initially, then 200 more, and finally 450 natives

Don Adams is the Resource Management Ranger at the park. His phone number is (812) 937-4541.

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evening or on weekends. Connections with GIS specialists from other agencies, organizations, and universities through conferences, and professional societies, were the key to getting the GIS lab jumpstarted during the Vision Fire.

Finally, GIS is a technical specialty, and its capabilities were not well understood by fire staff, which resulted in redundant efforts. For GIS to function smoothly in this environment, more than one person per agency is needed who has GIS experience (training) and an understanding of the capabilities and limitations of this management tool. A debriefing meeting, held shortly after the event, is also useful in documenting problems such as these and leading to improvements.

The Vision Fire at Point Reyes is a wake-up call for many private and public entities. Although impossible to contemplate and identify every problem in providing GIS related services during fires or other emergency operations, we are convinced that GIS is, and will continue to be, a vital tool to emergency responders in the future. We hope that by documenting our experiences, identifying the problems we encountered, and identifying preplanning considerations, more public and federal agencies will be better prepared to handle emergency incidents more effectively.

PS

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Sarah G. Allen, Ph.D., is an Ecologist with Point Reyes National Seashore and can be reached at (415) 663-8522, ext. 224; e-mail: sarah_allen@nps.gov. David Kehrlein and David Shreve are with the California Office of Emergency Services in Sacramento. Kehrlein's phone number is (916) 262-1699; Fax: (916) 262-1697. Shreve's number is (916) 262-1455, Fax: 916-262-1697. Richard Krause works for the Warm Springs Reservation in Warm Springs, Oregon; (503) 553-2416.

Book review continued from page 5

Research for the book was begun as a potential project for The Wildlife Society. But, in the end, The Wildlife Society refused to publish it and the authors sought out Island Press and several nonprofit foundations for publication support. One of the greatest values of the book is that it provides us a glimpse into the thought processes of some very accomplished people, some of whom have long histories of research in, and for, national parks, but all of whom seem to have problems with managing for "naturally evolving ecosystems." Most of the discussions are interesting, if dated, but do a better job of documenting the limitations and ambiguities of contemporary wildlife science than inculpating NPS management decisions. The reader will also find a substantial number of internal conflicts such as the admonition for developing more "park-specific, ecologically defined policies" and yet calling, also, for the minimum level of human interventions.

But in the end, even the "Future Directions" chapter disappoints. The authors call for using public input to set goals at the park level, integrate park and national park system goals, employ the least management possible, base management on quality research, consider management experimental, and monitor, monitor, monitor! If you've heard these things before (like, for the last 30 years), and don't need another dose of the obvious, you might check out Sam McNaughton's review of the book in the Journal of Wildlife Management [60(3):1996; 685-687] or just wait for the *Cliff Notes* version.

PS

Dan Huff is the Associate Field Director for Natural Resource Stewardship and Science, Intermountain Field Area. His phone number is (303) 969-2651.

Fire conference continued from page 11

scribed fire. Individual presentations were varied and meaningful. They described the most current techniques and procedures for wildland fire management, state-of-knowledge summaries, and new technologies including computer software.

Of particular interest was the panel discussion on political and philosophical limitations to prescribed fire. Panel members presented a stimulating exchange highlighted by Secretary of the Interior Bruce Babbitt's charge to reach a consensus among land users and to strive to make prescribed fire more effective and successful. Another panel member, while describing limitations to prescribed fire in a lighthearted fashion, may have actually given the most succinct summation when he stated that fear, greed, ignorance, and apathy are the principal limitations to increased prescribed fire application.

Several intriguing field trips augmented the formal presentation portion of the conference. These included tours of the National Interagency Fire Center; the Snake River Birds of Prey National Conservation Area; the World Center for Birds of Prey; and past, present, and future fire management considerations on the Boise National Forest.

The 20th Tall Timbers Fire Ecology Conference dealt with an important topic for present and future wildland fire management. Information shared will be valuable now and for years to come in enhancing understanding, learning, and application of management actions. Conference organizers should be proud as this conference achieved the goal of creating an environment where research and experience could be shared to further success and productivity in wildland fire and resource management. The sum and substance of the conference will be captured through peer-reviewed papers that will be published in a formal proceedings available during 1997.

PS

Tom Zimmerman is a Fire Management Specialist with the Fire Management Program Center unit of the NPS National Interagency Fire Center. His phone number is (208) 387-5215.

Evaluation process continued from page 21

in the line-item construction program (and the continued decline in available funding), large projects will become increasingly difficult to justify. In the future, extremely large projects such as that to improve water delivery to the Everglades (in Florida) and the Elwha Dam removal in Washington (restoring a river drainage for salmon and steelhead spawning) may be better considered outside the line-item construction program. It is difficult to develop a meaningful scale to cover projects where the magnitudes of costs and benefits are so different.

In Summary

This was the first time we used the new process and we learned a lot. We know that good judgment about relative differences among projects can be exercised only if the information about the projects is good; this time, that was not always the case. Many project writeups still "gilded the lily," but we learned what information and in what form is needed to facilitate objective judgments. Nevertheless, The assessment team felt that the system was fair. All participants worked hard and conscientiously, including trying to deal consciously with their personal biases.

Park resource managers may learn some lessons here. First, if construction solutions can help deal with resource problems, resource personnel should work closely with their facility manager as they design projects. Second, the definition of what constitutes a "construction" project is broader than many believe. If a project costs more than $500,000 and less than $20 million, it may be eligible for construction funding and it does not have to be a building; it could be a rehabilitation project. Third, projects that have resource benefits of any kind will receive more credit for those advantages if good, objective data are included in the package. Finally, the system is explicitly open to resource protection projects–resource-related projects will get a fair evaluation.

PS

Abby Miller is the Deputy Associate Director for Natural Resource Stewardship and Science. Her phone number is (202) 208-4650.

Ecological Restoration Workshops Announced

By William Jordan

The Society for Ecological Restoration is launching a new program of workshops for professionals involved in ecological restoration or related activities such as habitat or vegetation management, species restoration, or pest control. Lasting one to three days, the workshops will take place in 10 North American cities through May. According to John Rieger, District Biologist with the California Department of Transportation and one of the program coordinators, "a lot of people are getting involved in restoration work and they are looking for information [they] just can't find in books or journals. That is what we are offering through this program." Rieger explains that the workshops are the first step in creating the New Academy for Ecological Restoration, a school without walls that provides training for restoration practitioners.

The schedule for the first round of workshops is:

Budgeting Stewardship
Seattle, January 8; Sacramento, January 22; Denver, March 26

Desert Restoration
California City, April 30-May 2

Managing Seeds
Sacramento, January 29, April 4

Mycorrhizal Fungi
Morgantown, January 6-7

Plant Salvage
Seattle, January 15; Toronto, February 27; Dayton, April 15

Restoration Planning (Introduction)
Seattle, January 16-18; Toronto, February 24-26; Dayton, April 16-18

Restoration Planning
Phoenix, January 6-7; Sacramento, January 27-28; Denver, April 21-22

Soil Geomorphology
Seattle, January 9-10; Sacramento, January 30-31; Denver, March 27-28

Wildlife Habitat
Seattle, January 13-14; Sacramento, January 23-24; Denver, March 20-21

For further information about fees and registration, contact Katy Kressin, New Academy Workshops, Society for Ecological Restoration, 1207 Seminole Highway, Madison, WI 53711; Phone-FAX (608) 262-9547; e-mail: ser@vms.macc.wisc.edu; web site: http://nabalu.flas.ufl.edu/ser/SERhome.html. PS

William Jordan is on the faculty of the University of Wisconsin in Madison and can be reached at (608) 265-8557.

Meetings of Interest

February 5-8

The 33rd annual meeting of the Western Section of the Wildlife Society will take place at the Bahia Hotel in San Diego, California. The session is entitled, "Monitoring Our Wildlife Heritage: What do we have? How do we know?" For further details, contact Dr. Reginald H. Barrett, 145 Mulford Hall, Berkeley, CA 94720-3114; (510) 642-7261; FAX (510) 643-5438; e-mail: rbarrett@nature.berkeley.edu.

February 16-23

"West Mexico for Land Managers" is being offered as a field workshop by the Colorado Bird Observatory as a way to promote international conservation initiatives. Western Mexico provides winter habitat for a majority of North American migratory songbirds and many Mexican endemic species, and is a global conservation priority. The week-long field trip with Mexican biologists will provide hands-on experience with the birds, habitats, management areas, and land managers of western Mexico. Cost is $1,200 (room and board), and airfare is between $350 and $650. Contact Chuck Aid of the Colorado Bird Observatory for further information at 13401 Piccadilly Road, Brighton, CO 80601; (303) 659-4348; FAX (303) 659-5489; e-mail: cobirdob@aol.com.

March 14-18

The 62nd North American Wildlife and Natural Resources Conference will take place at the Omni Shoreham Hotel in Washington, D.C. This premier annual meeting of North American natural resource managers, scientists, administrators, and educators will explore the theme, "seeking common ground in uncommon times." Contact the Wildlife Management Institute for further information at 1101 14th Street, NW, Washington, D.C. 20005; (202) 371-1808; FAX (202) 408-5059.

March 17-21

Albuquerque, New Mexico, is the venue for the Ninth Conference on Research and Resource Management in Parks and on Public Lands, the George Wright Society Biennial Conference. While the bedrock assumption underlying the creation of parks and reserves is that they will be

Continued on back page

Meetings of Interest (cont'd)

MARCH 17-21

GEORGE WRIGHT SOCIETY MEETING CONT'D

protected in perpetuity, today's world is characterized by the dizzying pace of technological change, rapid human population growth, large-scale alteration of ecosystems, the disintegration of shared cultural views of history, declining government budgets, and an increasingly fragmented and volatile political climate. The theme of the conference, "Making Protection Work: Parks and Reserves in a Crowded, Changing World," acknowledges the rapidity of change and the difficulty of protecting cultural and natural attributes in parks over the long term and stresses the importance of innovative and flexible thinking to achieve preservation. Cosponsors are the National Park Service, Eastern National Park and Monument Association, and the USGS Biological Resource Division. Contact Bob Linn or Dave Harmon for further information at (906) 487-9722; FAX (906) 487-9405; e-mail: gws@mail.portup.com; or web site: http://www.portup.com/~gws/gws97.html.

APRIL 8-10

The U.S. Forest Service is sponsoring the conference, "Exotic Pests of Eastern Forests," which takes place this spring at the Club House Inn and Conference Center in Nashville, Tennessee. Organizers hope to increase awareness of existing and potential exotic pest problems in the eastern United States, discuss best management practices, and identify gaps in knowledge and technology. Sessions and posters will address mile-a-minute, honeysuckle, fire ants, chestnut blight, gypsy moth, purple loosestrife, and several other species. During a half-day field trip, experts from the Tennessee Department of Agriculture and Tennessee Exotic Pest Plant Council will discuss biodiversity and exotics, strategies for prevention and control, introduction and spread, public awareness and education, use of pesticides, and economic impacts on land values. Registration is $125. For more information, contact Dan Brown at (404) 347-7193 or Kerry Britton at (706) 546-2455.

MAY 12-16

SAMPA III, the Science and Management of Protected Areas Association conference, will take place in Calgary, Alberta, and will address the theme, "linking protected areas with working landscapes and conserving biodiversity." Five environments (marine, prairie, mountain, boreal forest, and the North) will be profiled. Abstracts are due January 17. Contact Patricia Benson, SAMPA III Secretariat, #552, 220 4th Avenue SE, Calgary, Alberta, Canada T2G 4X3; (403) 292-4404; FAX (403) 292-4404; e-mail: sampa3@pch.gc.ca; WWW: http://www.worldweb.com/ParksCanada-Banff.

MAY 18-21

Reno, Nevada, plays host to the Fifth National Watershed Conference, "Living in Your Watershed." Contact John Peterson for further information; FAX (703) 455-4387.

JULY 14-15

The Natural Resource Program Center, Geologic Resources Division, is cosponsoring the Rocky Mountain Symposium on Environmental Issues in Oil and Gas Operations, now in its fourth year. To be held at the Colorado School of Mines, the conference will address pollution prevention, ecosystem management, air and water quality, visual impacts, road and pad siting, and reclamation. Registration is $295 by June 16, $345 thereafter. The January 3 deadline for papers or posters is fast approaching. Contact Bruce Heise (NPS cc:Mail, e-mail: bruce_heise@nps.gov, or (303) 969-2017) for additional information.

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Volume 17 National Park Service • U.S. Department of the Interior Number 1

Exposure of Snowmobile Riders to Carbon Monoxide

Emissions Pose Potential Risk

Lori M. Snook Fussell

Figure 1. Snowmobile travel is gaining popularity in national parks, including Grand Teton National Park, Wyoming, the site of the recent emissions study.

By Lori Marie Snook Fussell

SNOWMOBILE travel (fig. 1) has become pervasive recreation in several national parks. During winter 1993-94, more than 87,000 tourists visited Old Faithful in Yellowstone National Park (Wyoming, Montana, Idaho) by snowmobile alone. Experts had predicted it would take 10 years for winter tourism to reach the 1993-94 level; however, it took only three (Wilkinson 1995; Thuermer 1996). Voyageurs National Park in Minnesota also experiences significant snowmobile traffic, with an estimated 30,000 snowmobiles entering annually (Wilkinson 1995). Snowmobile travel is also gaining popularity in many other national parks, such as Mount Rainier, Olympic, Grand Teton, and North Cascades (Wilkinson 1995).

Presently, no federal laws regulate the exhaust from snowmobile engines. The typical snowmobile operates on a small, two-stroke engine (around 400-650 cc). The two-stroke engine is less expensive than its four-stroke counterpart and provides a high power:weight ratio. However, it also produces relatively high emissions of carbon monoxide (CO) and unburned hydrocarbons (UHC) (White et al. 1993). Additionally, snowmobile engines are not equipped with pollution control equipment. Therefore, the typical snowmobile produces significantly more CO and UHC than a modern automobile.

Health Hazards

Carbon monoxide is a colorless and odorless gas that results from incomplete combustion. It is considered dangerous because it binds to the hemoglobin in blood (forming carboxyhemoglobin) and renders the hemoglobin incapable of transporting oxygen. The amount of carboxyhemoglobin and thus the effect on health is a combination of the concentration of CO in the air and the time of exposure. When exposure is discontinued, the CO that combined with the hemoglobin is spontaneously released, and the blood of healthy individuals is cleared of half of its CO in 3-4 hours. The effects on health range from neural-behavioral effects at 2-3% carboxyhemoglobin to headaches and fatigue at 10% carboxyhemoglobin to respiratory failure and death. Reduced blood-oxygen levels from CO exposure are particularly dangerous to the elderly, people with cardiovascular disease or other circulation problems, anemic individuals, fetuses, young infants, and pregnant women (U.S. Environmental Protection Agency 1991).

The National Ambient Air Quality Standard (NAAQS) for CO is 35 ppm (parts per million) for 1 hour and 9 ppm for 8 hours. This standard was established to keep blood levels of carboxyhemoglobin below 3%. However, some evidence sug-

Continued on page 8

PARK SCIENCE

Integrating Research and Resource Management

Volume 17—No. 1 • July 1997

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

ACTING DIRECTOR
Denis P. Galvin

ASSOCIATE DIRECTOR, NATURAL RESOURCE STEWARDSHIP AND SCIENCE
Michael A. Soukup

EDITOR
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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations–materials do not undergo refereed peer review. *Park Science* is also available online (ISSN-1090-9966) at *http://www.aqd.nps.gov/natnet/nrid/parksci.*

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to the National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Please refer to guidelines published in volume 16(3):5-6 and online, or contact the editor:

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Printed on recycled paper

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FEATURES

IN THE NEXT ISSUE. . .

Lake Mead Wildlife Biologist Mike Boyles will share his perspective on desert tortoise research, protection, and recovery in the Mojave Desert parks.

BRINGING OUT THE BEST IN US

OPPORTUNITY AND *PROGRESS* DESCRIBE MY SENSE OF THE NINTH GEORGE WRIGHT SOCIETY conference that took place in Albuquerque last March. From the showing of 560 resource managers, scientists, and administrators (50-60% from this agency), we clearly embraced this important biennial gathering of colleagues dedicated to preserving resources through research and management. Three regional directors attended, and at least 36 park superintendents or assistant superintendents were there contributing to the lively session and hallway discussions that characterized this upbeat professional science and resource management conference.

While this level of participation apparently reflects a strong concern for resource preservation at present, it come in cycles. The 1976 conference in New Orleans was also well attended by managers, but in 1990, some managers questioned the legitimacy of sending members of their own resource management staffs to the El Paso meeting!

This was a wonderful opportunity to learn about new research and discuss its application in park management. Over the course of 5 days, nearly 200 formal presentations took place and 70 posters were presented. Hallway discussions were numerous and productive, with conference-goers getting acquainted or exploring solutions to parallel problems from different parks. "The conference provides a connection that is a tonic for insularity," noted past George Wright Society President Gary Davis. "It makes us feel better about our own world."

George Wright was a revolutionary. He briefly succeeded in bringing a biologist's viewpoint to park management in the 1930s before his untimely death at a young age. Up against a deep-rooted tradition of providing for the enjoyment of parks by tourists, Wright sought to incorporate research into park management thinking. The relatively high turnout of managers at this meeting is an encouraging demonstration of support for resource preservation. Now, we must try to keep this level of interest from waning.

Jeff

Corrections

Last issue, our review of the Ecological Society of America Conference–16(4):10–incorrectly listed the author, NPS Wildlife Biologist Michael Britten, as an employee of the Rocky Mountain System Support Office; he is with the Colorado Plateau Support Office. Britten also wrote to mention that he neglected to include a complete listing of all presentations made at the conference by NPS employees. Two that he left out were, "Applying conservation biology and ecosystem management in the Santa Monica Mountains National Recreation Area," by R.M. Sauvajot, D.A. Kamradt, R. Rumball-Petre, P. Jenkins, and J. Benedict. The other, "Evaluating bobcat viability in the Santa Monica Mountains, California," was presented by D.A. Kamradt and R.M. Sauvajot.

Park Science online was announced last issue in the News & Views department, but an incorrect World Wide Web address was given. The correct URL is *http://www.aqd.nps.gov/natnet/nrid/parksci.*

Dear Editor,

I want to clarify some inaccuracies in the article, "A Different Spin on SSO Support"–16(4):8. The story credits John Karish, Chief Scientist of the Allegheny-Chesapeake Support Office, as having placed the 4-year term NPS Natural Resource Specialist (Michele Batcheller) at Penn State. This was accomplished through the Resource Management and Visitor Protection Division at the former Mid-Atlantic Regional Office where Chris Andress was the Division Chief and I was the Natural Resource Branch Chief. As the article asserts, Karish has coordinated the regional, and now cluster, science program for the past 16 years, but not the Natural Resource Program. This has been my responsibility for the past 5 years, and Kathy Jope (now with the Columbia-Cascades Support Office) was responsible for it before me. Last fall, Wayne Millington, an integrated pest management specialist, became the third support office employee duty stationed at Penn State. Presently, I supervise all three of the NPS staff at Penn State.

Dave Reynolds
Manager, Park Planning & Natural Resources Group
Chesapeake-Allegheny Support Office

Report Tracks Issues and Trends in Resource Management

The long-awaited *Natural Resource Year in Review–1996* is now online at *http://www.aqd.nps.gov/natnet/pubs/yr_rvw96.* You can access it by visiting the NatureNet home page on the World Wide Web and clicking on the feature article image on that page. The printed edition should arrive in parks concurrent with this issue of *Park Science* and has been circulated to superintendents, division chiefs, and resource managers at all units of the national park system. It also has been given broad circulation beyond the National Park Service.

The report summarizes and analyzes the most significant natural resource issues and trends in the national park system for the calendar year. Applied science and resource management stories are reviewed with the objective of increasing interest in, understanding of, and support for the natural resource stewardship role of the National Park Service.

Stay tuned this fall for a call for article ideas for the 1997 edition of the report. Thanks to all who contributed to this inaugural report.

USGS Plans for Future

The U.S. Geological Survey (USGS) recently published a 68-page strategic plan for the agency that will guide it until 2005. The report examines the current socio-political environment and charts the general course for the agency over that time span. The document, which can be viewed in its entirety on the World Wide Web at *http://online.wr.usgs.gov/stratplan/splan/main.html*, addresses demographic changes, public investment in science, society's concept of "public good," economic versus environmental interests, and the scarcity and management of natural resources. The document also stresses the need for continuing partnerships and developing long-term national databases.

The plan clearly reflects a developing change in program emphases. Over the next 10 years, the agency will emphasize: long-term interdisciplinary studies, mitigation studies, quality and accessibility of resources, international mineral-energy studies, nontraditional disciplines, regional and national studies, geospatial data integration, applied research and development, technology transfer, engaging in controversial issues, issue-driven studies, studies involving population centers, multiple-risk assessments, digital products, and real-time event responses.

Issued in May 1996, just half a year after Congress directed the National Biological Service to consolidate with the U.S. Geological Survey and half a year before this actually happened, the report does not go into details about the merger. Instead, the 19-page *NBS Strategic Science Plan,* published last October, guides the initial scientific efforts of the new Biological Resources Division (BRD) within the parent 118 year-old science agency.

Last October 1, the consolidation of the two agencies took place and BRD became the fourth division of the USGS, alongside water resources (the largest), geologic resources, and national mapping. Denny Fenn, former acting NPS Associate Director for Natural Resources and recently the NBS Western Regional Director, was appointed the first Chief Biologist of the new division.

Addressing a plenary audience at the George Wright Society conference last March, Fenn pointed out some benefits to the National Park Service of his division being situated with USGS. Many of the former cooperative park studies units, which are base funded, will be reestablished as park field stations, making them more accessible to parks. Furthermore, the BRD supports the establishment of cooperative ecosystem studies units and will share its key skills to make the proposal work.

Now, we must not turn our backs on the new division. We have the opportunity to forge partnerships with them, which will help form an agency culture that is responsive to our needs. Let us start by learning who to call and asking for assistance.

WILD FORESTS, CONSERVATION BIOLOGY, AND PUBLIC POLICY

By Alverson, Kuhlmann, and Waller

A BOOK REVIEW BY ROBERT G. WILLHITE

HOW MUCH OF EACH TYPE OF FOREST must be set aside in a preserve to ensure its perpetuation? This age-old question is the premise of the consciousness-raising book, *Wild Forests, Conservation Biology and Public Policy.* Accompanied by an impressive literature review, the work examines the conservation ethic, history, law, and natural forest dynamics as they relate to preserving forest resources. The USDA Forest Service and its "multiple use" management policies are criticized for not adequately protecting forest lands, with some mention of the USDI, Bureau of Land Management. One solution the authors propose is to reassign the biodiversity protection responsibilities to another agency. The National Park Service might fit their model. The authors maintain views that closely fit the resource *conservation* mandates of the NPS Organic Act (legally interpreted as preservation), and they write that national parks and wilderness areas could form the core of many of the needed forest preserves.

On public lands where timber harvesting is part of multiple use, the authors propose that forest management planning should "require proof of harmlessness to be furnished by those who propose intensive disturbance of the landscape." Thus, they demand the impossible of these other federal agencies because throughout the book they "readily admit that vast amounts of this information are unknown to us all." Such an unrealistic view only further frustrates resolution of important issues and does not help the agencies charged with making appropriate environmental decisions. This unreasonable expectation clouds their otherwise valid discussion to seek change in forest management. In general, the authors present concepts that need consideration by foresters, land managers, agencies, and timberland owners alike.

GUILT—REASON FOR CHANGE?

Early in the text, the authors succumb to, or apply, a popular belief that *guilt* about past human activity is the reason we must make changes for the future. For example, they hold rigidly to the view that precolonial forests were pure and pristine. To the contrary, research in the early 1900s by Harvard University found that journals of colonists like Cotton Mather in the 1600s described forests whose trees, intolerant of shade, could not reproduce in late successional stages. Surprised, the Harvard researchers analyzed the "pit-mounds" associated with windthrown root wads, and found that the precolonial forests did not retain their "virgin"-ity. Massive periodic disturbance from hurricanes had occurred about every 150 years, sometimes associated with subsequent fire. Although the authors recognize and thoroughly discuss the role of such natural disturbances, they do not fully incorporate these concepts into their arguments for improved forest planning and management.

Their theme of guilt continues when they suggest that humans caused extinctions of the ground sloth, giant beaver, saber-tooth cat, and horse. This is a highly controversial premise with little scientific evidence to support it. Some kill sites of mastodons with indications of butchering by humans are known, as well as "jump sites" where bison were run off cliffs. Humans cannot be singled out as the cause of extinction, but may have added to the natural influences of vulcanism and climatic changes that forced adaptation or migration, in addition to extinction. The book effectively makes the point that changes in present forest management are needed without including these common guilt-directed justifications.

Wild Forests (©1994) *is available from*

Island Press
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http://www.islandpress.com

Cloth: $52.00
(ISBN 1-55963-187-2)
300 pages

Paper: $27.50
(ISBN 1-55963-118-0)
300 pages

($5.75 shipping & handling)

DIVERSITY MANAGEMENT AREAS

The authors call for diversity management areas (DMAs)–large tracts of forest that include old-growth and some natural disturbance–as a solution to the problem of diminishing forest resources (fig. 1). The DMA model uses concentric rings where management is minimal in the center and more intense on the periphery. This concept was taught in forestry schools in the late 1960s and is now widely applied in the protection of wilderness areas. They state that timber and game management, and many forms of recreation, would be focused elsewhere but they do not propose where. They recommend that the minimum-sized DMA be about 50,000 acres or roughly 75 square miles. They state that domestic law and policy need emphasize management precautions to prevent a loss in biodiversity. Their charge

that species and site management need to be changed is well supported in their case studies and citations.

Social Factors

The authors do not address a dilemma in their call for natural disturbances by fire, wind, and ice damage; society probably will not tolerate *extensive* losses of forest resources imposed by unchecked natural processes in the East and many areas in the West. Policies can be formulated that consider both the benefits of periodic fire, and weigh the potential risks of allowing fires to burn. An example is the NPS policy of fire control in wilderness areas, developed after the Yellowstone conflagrations. After extensive wind damage, managers typically consider reforestation efforts or wood salvaging operations to reduce wildfire risks.

JEFF SELLECK

ure 1. The diversity management area idea proposed he authors focuses on the preservation of large blocks elatively unmanaged lands. Falling short of wilderness ignation, the (lack of) management scheme centrates consumptive and recreation uses elsewhere onserve old-growth forest and biodiversity.

Addressed at length are the problems of fragmentation, "edge effects" from harvesting, and roads caused by rapidly increasing human infrastructure in much of our forest landscape. However, they never suggest how to resolve these problems. They also note the jurisdictional challenges posed by state, county, and private ownership of forest lands that would need to be addressed for DMAs to succeed in the eastern United States. They fail to mention a similar, widespread situation in the Sierra-Nevada mountains of California and Oregon where land ownership is fragmented as a result of railroad land grants meant to encourage westward expansion. Land acquisition by government is an integral part of their proposed solution, albeit not a popular one at present.

A major factor not pursued in their discussions is economics. As the U.S. government withdraws lands from timber harvest, it also reduces revenues to the U.S. Treasury. Reduced federal budgets affect agencies and their abilities to manage forest resources. How can lost production on federal lands be offset by more intense management on private forest lands? Only about 14% of the nation's forests is owned by industrial timber companies but more than 50% is owned by smaller, private entities; economics is the primary force affecting their decision whether to harvest or not. Reduced taxes for incentives further limits potential treasury funds. These issues will require close examination and resolution before the authors' ideas can be put in to practice.

Information Needed

A key point made regarding managed forest lands is that human-applied processes must imitate nature. In citing forestry professor Jerry Franklin's "biological legacy" of leaving undisturbed remnants in managed areas, the authors furthered their call for responsible forest management. Foresters would probably provide the greatest environmental benefit by reflecting upon and applying these simple techniques. Conscientious foresters want to take good care of their lands, think they have most of the solutions, and believe that they understand the ramifications of their actions. Unfortunately, the authors correctly note, despite good intentions, many management decisions are not backed by complete information.

The authors make a clear and concise case for the importance of research and inventory and monitoring, matched with appropriate budgets. According to them, a separate agency, such as the National Biological Service (now the USGS Biological Resources Division), is the best way to meet this charge.

It would be interesting to hear the authors' opinions of some of the ongoing ecosystem management plans, such as the Snake and Columbia River systems in the West. One might guess that they would consider any planning venture to date as inadequate because necessary information is not yet available. Have the authors provided the solution for preserving forest biodiversity? Time and society will decide.

PS

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GULF COAST

Barrier Island Habitat Restored

Hurricane Opal made landfall on October 4, 1995, just east of the Florida District of Gulf Islands National Seashore, Florida and Mississippi. Most of this district is located on Santa Rosa Island, which is over 40 miles long and runs east to west. It is bordered by the Gulf of Mexico to the south and Escambia Bay and Santa Rosa Sound to the north.

The morphology of the island was altered as a result of the storm surge. Frontal dunes were leveled and sand was deposited inland forming vast tracts of sand fields. The surge caused extensive damage to Fort Pickens Road and State Road 399, the park's main roads, which were breached in numerous places and severely eroded elsewhere.

The storm surge deposited pieces of asphalt north of the roads and inland for over 4 miles in one area and 7 miles in another. Some of the pieces were intact sections of highway ranging in size from that of a dining room table to smaller than a marble. The debris was plainly visible from the newly rebuilt roadways and the north shore beaches, and copious amounts were located in areas that had been used for nesting by Least Terns *(Sterna antillarum),* a threatened species in Florida, in the summer of 1995. We were concerned that these anomalous pieces of asphalt might affect where they would choose to nest in years to come.

This past winter, park resource managers began the almost insurmountable task of picking up the asphalt, piece by piece, and having it removed from the island. We gave thought to having an asphalt company recycle the pieces, but this was not practical because every chunk was covered with foreign material, primarily sand.

Volunteering to help on four occasions were groups of 10-40 individuals who cleaned some of the areas. Also, park staff hauled asphalt to the road using ATVs (all-terrain vehicles) outfitted with trailers. The volunteers used 5-gallon buckets to transport small pieces of asphalt to the road shoulder or dump in an ATV trailer.

The U.S. Marine Corps also helped out. Approximately 100 marines collected and hauled pieces of asphalt to the road shoulder. This work was performed in one day, and approximately 103 cubic meters (135 cubic yards) of asphalt were removed and placed along the road for pickup. A local waste company donated a 20-cubic yard construction debris dumpster to aid the clean-up.

The park contracted to have large pieces of asphalt removed with a front-end loader and dump trucks. This work was only performed in areas with little or no vegetation. The front end loader also removed the asphalt piles that volunteers had placed on the road shoulders.

Altogether, approximately 191 cubic meters (250 cubic yards) of asphalt were removed. The majority was picked up by hand and totalled approximately 119 cubic meters (155 cubic yards); another 73 cubic meters (95 cubic yards) were removed with front-end loaders.

What started out as a small effort grew into a large one. At first the job seemed nearly impossible, but with hard work and persistence we succeeded in removing a large percentage of the debris from this island ecosystem.

Hurricane a Boon to Nesting Terns

Our concern for nesting Least Terns was an important consideration in pursuing the arduous cleanup of asphalt from Gulf Islands National Seashore following Hurricane Opal (previous story). In addition to tearing up and redepositing the asphalt from park roads, the powerful hurricane transformed a 4-mile stretch of Santa Rosa Island from a dune field into a flat sand expanse with little or no vegetation. The storm surge spread old road bed material (gravel) and sand from the dunes over the northern half of the island creating, ironically, ideal nesting areas for these and other bird species. In the 1½ years since the hurricane, the Least Tern, Snowy Plover *(Charadrius alexandrinus),* Wilson's Plover *(Charadrius wilsonia),* and Black Skimmer *(Rynchops niger)* have all nested successfully and fledged young in the areas disturbed by the storm.

The park was not able to monitor the birds closely due to personnel shortages. However, staff made frequent observations of the birds from the road. While some areas were too far away to confirm the presence of a nest, at least 60 tern nests were observed in four separate colonies. At least four pair of Snowy Plovers nested near the tern colonies. Approximately 40 skimmers began nesting behavior in one colony, with all but one pair abandoning the area. At another area, Least Terns, Snowy Plovers, and Wilson's Plovers all nested successfully.

To protect the nesting birds, the park posted area closure signs near the colonies, which worked well to minimize disturbances. The U.S. Navy at Pensacola Naval Air Station agreed to divert most helicopter flights away from the birds, and by the end of June 1996, the terns were well on their way to having a successful nesting summer. The terns are nesting again this summer in greater numbers than last year.

ROCKY MOUNTAINS

Yellowstone Potpourri

The Wolves of Yellowstone, a new book by Yellowstone National Park biologists Mike Phillips and Doug Smith, along with photographers Barry and Teri O'Neill, was recently published by Voyageur Press. Royalties from the sale of the book support the Yellowstone wolf restoration project.

The Interagency Grizzly Bear Study Team has documented a record year in 1996 for reproduction in the greater Yellowstone grizzly bear population: 33 different female bears produced 70 cubs-of-the-year (average litter size 2.1 cubs per litter). This is the highest number of unduplicated female grizzlies with cubs ever counted in the ecosystem in 1 year. The highest number of females with cubs previously counted was 25 in 1986. The most cubs previously counted was 57 in 1990.

The park is participating in a cooperative study to sample grizzly bear DNA from hair samples collected at specially designed hair-snagging "trap" sites. One long-term objective of the study is to develop an alternative method for estimating minimum grizzly bear population numbers within portions of the ecosystem. In 1996, the study concentrated on determining an effective, easy-to-handle bear attractant that could be used without giving bears a food reward. Lab work for determining how many individual grizzly bears the collected hair samples represent should be finished by the spring of 1997. If

all goes well the study will be continued in the summer of 1997 with emphasis on determining the optimum spacing distance of hair-collection sites for the most cost-effective means of sampling the population.

Biologists report that a total of 786 lake trout were taken from Yellowstone Lake in 1996 by gillnetting operations and park anglers. The nonnative fish, discovered in 1994, poses a serious threat to the native Yellowstone cutthroat trout. Researchers located a major spawning area around Carrington Island in the West Thumb of the lake during summer 1996, and are using information collected in 1995-96 to develop a long-term program to control the invader fish.

Colorado Plateau

Interagency Fish Management at Glen Canyon

Glen Canyon National Recreation Area (NRA), Utah and Arizona, signed an interagency fish management plan last year to facilitate cooperative fish management and endangered species restoration in the recreation area. Of particular interest and specifically addressed in the plan are four endangered, four native, 10 sport, and six other park fish species.

Park waters are diverse and require different management approaches for species occupying different habitats. The plan establishes goals and objectives for fish species occupying five different habitats within the national recreation area: flowing rivers, inflow areas, Lake Powell, dam tailwater, and perennial or intermittent streams.

This cooperation facilitated the establishment of a memorandum of understanding (MOA) between the recreation area, the Utah Division of Wildlife Resources, and the U.S. Fish and Wildlife Service. The MOA authorizes release of marked, captive-reared, endangered fish into critical habitat. As a result, 297 endangered razorback suckers were released to mature in golf course ponds in Page, Arizona, a community adjacent to the park. This project is the core of a high school advanced biology course and is part of a 3-year, grant funded, education program between Glen Canyon NRA and the school. In May, 30 fish were fitted with transmitters and are now being tracked by National Park Service, Bureau of Reclamation, and USGS Biological Resources Division biologists.

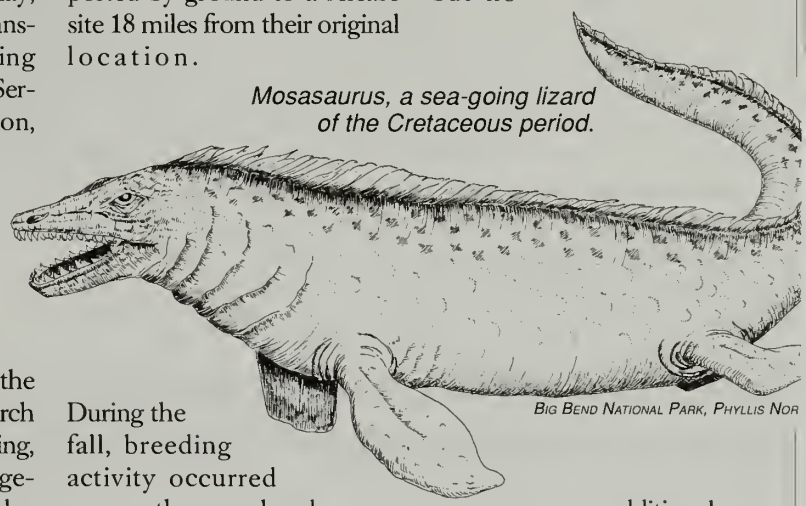
Interagency work to carry out the provisions of the fish management plan is accomplished through annual meetings for the review and approval of research proposals, planning monitoring, and coordinating fish management activities. The group also exchanges data and study results, pursues multiagency funding initiatives, and addresses research permit needs.

The plan has proven to be valuable. Management efforts are now better coordinated, goals and objectives are shared by all, and resource management activities are more efficient.

Great Plains

Bighorn Sheep Studied at Badlands

Between 1991 and 1995, Badlands conducted research on bighorn sheep as part of a NRPP (Natural Resource Preservation Program) initiative. The studies looked at population home range, habitat utilization, demographics, foraging ecology, disease ecology, and genetics. In 1995, data from these studies were paired with a GIS-based bighorn sheep habitat assessment, resulting in a management decision to restore sheep to large areas of unoccupied suitable habitat. The first translocation took place last October when 12 ewes and four young rams were netted by helicopter from the park's main herd, radio collared, and transported by ground to a release site 18 miles from their original location.



Mosasaurus, a sea-going lizard of the Cretaceous period.

BIG BEND NATIONAL PARK, PHYLLIS NOR

During the fall, breeding activity occurred among the new band, and at least four mature rams from the source population were involved. By the end of winter, three of the four rams returned to their former bands. In May, nine ewes gave birth to 10 lambs; as *Park Science* went to press, eight ewes and nine lambs had survived. The park continues to monitor the effects of translocation on the source herd.

First Mosasaur Discovered at Badlands

In response to a visitor discovery last October, a park paleontological team verified the first fossil specimen of a mosasaur (genus Mosasaurus) at Badlands National Park, South Dakota, on November 8, 1996. A marine lizard, the mosasaur lived at sea 75 million years ago and fed on fish. The discovery is of a juvenile, about 15-feet long, perhaps half of adult size, and the team recovered part of the jaw and some vertebrae. Dr. Gordon Bell, visiting professor at the South Dakota School of Mines and Technology and a mosasaur expert, was among the field team. Follow-up field work has revealed other vertebrate fossils that provide more information about the time period in which the mosaur lived, but no additional mosasaur remains have been discovered.

Badlands is world famous for its assemblage of Oligocene-Eocene mammalian fossils and is the birthplace of North American paleontology. Recently, paleontologists have begun looking for fossils in older rock formations in the park, which are slowly yielding additional glimpses into the past. Under the direction of park paleontologist Rachel Benton, the less studied Pierre Shale of the Late Cretaceous period has been the subject of considerable scrutiny during the last 2 years. Such efforts paid off in the case of the mosasaur discovery, which was made in this older formation.

Snowmobiles continued from cover

gests adverse health effects can occur at lower exposure levels, and the standards have been criticized (Watson 1995; Greek and Dorweiler 1990).

Emission Studies

The increase in popularity of the snowmobile and its polluting emissions have increased concern that snowmobile pollution in parks is reaching significant levels. As a result, several researchers have conducted investigations to determine whether this concern is justified. All of their studies focused on measuring the amount of CO in areas frequented by snowmobiles.

During winter 1994-95, National Park Service employees monitored ambient levels of CO at the west entrance station to Yellowstone National Park. The purpose of their study was to determine if National Ambient Air Quality Standards for CO were being exceeded. During winter 1994-95, no NAAQS exceedences occurred during the NPS monitoring study at the west entrance station. However, investigators did take samples on the snowmobile trail for informational purposes. The 1-hour bag samples taken near the entrance exceeded 35 ppm at two sites and the 8-hour average CO concentration exceeded 8 ppm at one site (Yellowstone National Park 1995). Therefore, concentrations at the west entrance exceeded levels established by the government to protect public health. However, the sampling method and locations used to collect this informal data did not meet guidelines for determining NAAQS compliance. Therefore, the results did not require national or state officials to take action. However, the results are scientifically valid and indicate the potential exposure of snowmobile tourists to significant CO levels.

During winter 1995-96, an informal study was conducted at Flagg Ranch in Grand Teton National Park, Wyoming. The conclusion was the same as that from data gathered at the west entrance in Yellowstone, namely that tourists may be exposed to significant levels of CO. However, a violation of national standards is not expected under present traffic populations due to the siting criteria used to determine compliance with National Ambient Air Quality Standards.

In yet another informal study, Yellowstone National Park rangers fitted with sampling equipment drove from West Yellowstone, Montana, to Old Faithful in typical snowmobile tourist fashion. The 1-hour CO samples that they collected were as high as 36 ppm. This was a very informal investigation that nevertheless illustrates the exposure of snowmobile tourists to significant levels of CO.

National park visitors traveling on snowmobile trails may be exposed to significant levels of carbon monoxide

Because of the increasing concerns about pollution from snowmobiles and the informal data to this effect, we undertook an investigation to quantify and predict exposure to pollution for people who travel on a trail behind another snowmobile.

Our research objectives were to quantify the amount of CO emitted from a snowmobile under steady-state conditions, to quantify the amount of CO an individual is exposed to while driving behind another snowmobile as a function of speed and distance behind that snowmobile, and to develop a model to predict exposure to CO and other pollutants while traveling in the wake of a snowmobile.

Study Area and Methods

We performed all emission and exposure testing along a section of snowmobile trail in Grand Teton National Park (fig. 1, page 1). The trail was ideal for testing. It ran along a valley floor and was relatively flat and straight. Snowmobile traffic was light and did not interfere with controlled test conditions. Additionally, air inversions in this site in winter were strong and permitted us to take the exposure measurements in extremely calm conditions.

Lori M. Snook Fussell

Figure 2. The study took place on flat terrain in Grand Teton National Park and involved a test snowmobile equipped for airflow measurement and exhaust sampling.

To determine the amount of CO emitted from a snowmobile under steady-state conditions, we measured the rate of airflow into the engine and collected bag samples of snowmobile exhaust while traveling at four different speeds over flat terrain (fig. 2). The speeds ranged from 10-40 miles per hour (mph) in order to cover the range of speeds usually occurring on park snowmobile trails. We then measured the CO concentration in each sample bag back at the lab (fig. 3). We used the data to calculate an average mass emission rate of CO for each speed.

To quantify the CO exposure of a following snowmobiler, we took bag samples at five different distances and four different speeds behind a moving snowmobile. We accomplished this by riding a second snowmobile at fixed distances behind the first snowmobile while collecting bag samples (fig. 4). The distances ranged from 25-125 feet. The speeds were the same as used in determining CO emission rates. We also took CO samples in the absence of a lead snowmobile so that we could correct the data for CO from self-exposure. Every effort was made to take exposure data under stable atmo-

JERI M. SNOOK FUSSELL

gure 3. Snowmobile exhaust was collected in gs in the field (arrow), diluted, and then alyzed in a laboratory. The canisters contain ses used to calibrate the carbon monoxide alyzer.

spheric conditions. We wanted to predict the maximum exposure possible for individuals that follow another snowmobile.

Results

The average steady-state CO emissions ranged from 9.9 g/mile (99 g/hr) to 19.9 g/mile (795 g/hr) (Table 1, page 10). The current national CO emission standard for new cars is 3.4 g/mile (Black 1991). However, automobile emissions are measured while the vehicle is driven according to a prescribed driving schedule. Therefore, the CO emission standard for automobiles represents the average CO emitted from a vehicle under a variety of driving conditions including acceleration and idling. We measured CO snowmobile emissions under steady-state driving conditions only. Therefore a comparison of the CO emissions that we measured with automobile emissions would be improper. To compare the snowmobile emission results in our study with automobile emission standards, we must know the steady-state CO emissions from an automobile.

In a recent study at the University of Tennessee, Sluder (1995) measured steady-state CO emissions from a 1988 Chevrolet Corsica. For speeds ranging from 10-40 mph, the steady-state tailpipe emissions of CO ranged from 0.01 to 0.04 g/mile. These values are approximately 1,000 times smaller than the steady-state snowmobile emissions we measured in our investigation. Therefore, our results support the claim that snowmobiles produce significantly more CO than a present-day automobile.

JERRY B. FUSSELL

Figure 4. The study required a constant distance between the emitting snowmobile (front) and the trailing snowmobile that recorded the exhaust concentrations.

Average carbon monoxide exposure measurements (corrected for self-exposure) at speeds from 10-40 mph and distances of 25-125 feet ranged from 0.5-23.1 ppm (Table 2, page 10). The highest individual measurement was 45 ppm. In interpreting these data, one must remember that we measured CO exposure behind only one snowmobile. The average size of a snowmobile group in Yellowstone is eight snowmobiles (Machlis 1995). As many as 1,000 snowmobiles may travel to Old Faithful during one day, and, from the west entrance, the trip requires about an hour of driving at 40 mph. Considering that snowmobilers typically travel behind more than one snowmobile for sustained intervals, one can see that their exposure to CO is clearly significant. An additional consideration is that many snowmobile trails are located at high altitude. The general consensus among medical and air pollution professionals is that the risk to health from CO increases at high altitude, especially for unacclimated individuals (National Commission on Air Quality 1980). Therefore, a park visitor living at sea level who rides on high-altitude snowmobile trails is more susceptible to the effects of CO than local residents.

Using the emission and exposure data from our investigation, we developed a simple model to predict exposure to CO while traveling in the wake of a snowmobile. This model is valid under stable atmospheric conditions in no or light wind. We will also be able to use this model to predict exposure to the unburned hydrocarbons including air toxics present in snowmobile exhaust when information becomes available. This will provide useful information on exposure to pollutants other than CO without requiring more expensive testing.

Implications

The major implication of this research is that national park visitors traveling on snowmobile trails may be exposed to significant levels of CO. Although the steady-state exposure data from one snowmobile does not indicate average exposures greater than 35 ppm, many factors lead us to believe that CO exposure may be significant.

1. Snowmobile tourists typically travel in large groups. Exposure to CO for the last person in the group will be significantly higher than the concentrations we measured behind only one snowmobile.
2. Our investigation dealt with only steady-state conditions. Snowmobiles emit more CO when under power or accelerating. Therefore, the steady-state emissions we measured are a "best-case" emission volume. Exposure will increase at other than constant speed.
3. Park snowmobile trails force snowmobilers to travel directly behind other snowmobiles. The wake of leading snowmobiles cannot be avoided other than by keeping a large gap between snowmobiles.
4. Many park trails are at high altitude where the effect of CO on unacclimated people is intensified.

Continued on page 10

Continued from page 9

5. In many parks, air inversions are strong and create calm conditions that prevent the rapid dispersion of pollution.

Table 1. Average steady-state carbon monoxide emissions from a snowmobile

Speed (mph)	Average CO Emission (g/mile)
10	9.9
20	10.5
30	10.8
40	19.9

Table 2. Carbon monoxide exposure measurements at various speeds and distances. Each value is corrected for self-exposure and represents the average of 4-5 independent tests

Speed (mph)	Distance (ft)	Average CO Exposure (ppm)
10	25	23.1
	50	2.6
	75	0.5
	100	2.4
	125	5.1
20	25	13.0
	50	5.4
	75	2.4
	100	3.4
	125	1.8
30	25	12.1
	50	5.0
	75	3.5
	100	6.69
	125	3.0
40	25	19.6
	50	11.1
	75	8.6
	100	8.9
	125	8.4

6. Many trips on national park snowmobile trails require several hours of driving, increasing exposure to CO.
7. Exposure data from our study were corrected to disregard self-exposure to CO. We measured as much as 10 ppm of CO from self-exposure under steady-state conditions. This self-exposure is expected to increase with a tailwind or while decelerating.

Suggestions

The exposure to pollution from snowmobiles on park snowmobile trails may be reduced by a reduction in the emissions from snowmobiles, a decrease in the numbers of snowmobiles on park trails, and avoidance by snowmobilers of stable weather conditions and high-density traffic where significant exposure may occur.

Reducing the emissions from snowmobiles is the most desirable option. In this way, snowmobilers may continue to enjoy popular destinations without restriction. It *is* possible to make snowmobiles less polluting. One easily implemented first-step is requiring the use of oxygenated fuels. A recent study on small two-stroke engines (Sun et. al. 1996) concluded that oxygenated fuels can reduce UHC and CO emissions by 10-20%. Additionally, their high octane rating can improve engine performance. During winter 1996-97, Yellowstone National Park snowmobiles were run on oxygenated fuels to evaluate the feasibility of this alternative. Other technological options include switching to a small, four-stroke engine with conventional pollution control equipment, running a two-stroke engine slightly lean with catalytic after-treatment, or using a two-stroke engine with fuel injection (with a redesigned combustion chamber). All of these solutions will increase the cost of snowmobiling.

Decreasing the amount of snowmobilers on park trails is the most controversial solution. However, if emissions from snowmobiles are not reduced voluntarily, this may be the only effective option.

Finally, snowmobile tourists should be warned of the potential exposure to pollution and taught to recognize early signs of excessive exposure. They can decrease their own exposure by traveling in small groups, touring on windy days, turning off the engines of stationary snowmobiles, avoiding popular destinations during peak season, driving far behind other snowmobiles, and by driving off-centerline whenever safe and legal.

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A Nontraditional Cooperative Approach to Natural Resource Management

Timber Harvest Will Lead to Area Restoration at Timucuan Ecological and Historic Preserve

Daniel R. Tardona

Figure 1. Planted stands of slash pine and loblolly pine are scheduled for harvest in 2002 at Timucuan. The vegetation restoration plan, developed to guide the transfer of land ownership to the National Park Service, allows for commercial harvest of the trees by the property owner, who will fund subsequent restoration of the site to a more natural condition.

By Daniel R. Tardona

The Timucuan Ecological and Historic Preserve is a 46,000 acre unit of the national park system that was established in 1988 to protect wetlands and uplands in Duval County, Florida. Unlike many traditional units, the Timucuan Preserve consists of publicly and privately owned lands. Approximately 8,000 acres are owned by the National Park Service with the remainder owned by many different private and governmental parties.

The Castleton Beverage Corporation, a subsidiary of the Bacardi Corporation, owned approximately 927 acres of ecologically and culturally significant land in the preserve. Known as the Thomas Creek Area, the Castleton property contained open fields, numerous small ponds, a 27-acre lake (a borrow pit), 262 acres of fresh water wetlands, and approximately 145 acres of brackish marshlands. A few dirt roads provide access within the property. The upland portions of the site have been used for silviculture by Castleton. Loblolly pine *(Pinus taeda)* and slash pine *(Pinus elliotii)*, originally planted in rows on raised beds, were to be harvested by the corporation when the trees attained their maximum value as timber (fig. 1). Castleton had planned to cut nearly all the stands of trees on the site including natural stands of slash pine and pond pine *(Pinus serotina)*. After harvesting, Castleton planned to explore options offering the most economic benefit including sale of the land for development.

Land Acquisition

The Timucuan Ecological and Historic Preserve is mandated to ensure that current and future uses of uplands inside and adjacent to its boundaries do not impair significant natural habitats, water quality, or healthy salt marsh and estuarine systems. The planted forest in the Thomas Creek Area was not in keeping with the mandates of the preserve, and acquisition and subsequent restoration of the vegetative cover could have been too costly. Consequently, the administration of the preserve pursued a nontraditional approach in the acquisition of the land from the Castleton Beverage Corporation beginning in 1990. Ultimately, the land was acquired through a combination of a land donation and public and private funding to purchase the remaining portion. The land acquisition contract required the development of a vegetation management plan for a transition of the vegetative cover from a pine plantation to natural vegetation of the area.

Vegetation Plan

Staff from the preserve and Great Smoky Mountains National Park along with a forester from the Castleton Corporation and various professionals from other state and local resource management agencies produced the vegetative resource management plan. According to the plan, all loblolly pine and slash pines will be harvested in 2002. Natural slash pine stands that provide buffer zones around the lake and along wetland margins will not be removed. Selected stands of natural slash pines will be thinned in order to improve species reproduction and to create a mixed two-aged stand of slash pine and longleaf pine. All pond pine stands will be left in place. After harvesting, the Castleton Beverage Corporation will fund restoration of the site. This will include planting longleaf pine *(Pinus palustrus)* in designated harvested areas at different times in order to achieve a multiple age effect and mimic natural regeneration over several years. The plan is expected to return the area to a more natural vegetative state as observed by presettlement visitors to the area.

The Castleton Beverage Corporation will realize the economic value of the timber that under traditional NPS land acquisition methods would have been lost. If the property had been acquired by the National Park Service without the removal of the loblolly pine, long and costly removal of the trees and transition of the site to a natural state probably would have taken years and may possibly have been cost prohibitive. The nontraditional cooperative approach to the acquisition and management of natural resources demonstrates that tangible benefits for conservation and for the corporate world can be accomplished without compromising the NPS vision of resource protection.

Dan Tardona is the West District Supervisor in the Interpretation and Resource Management Division at Timucuan Ecological and Historic Preserve in Jacksonville, Florida. His phone number is (904) 641-7155.

Does the Public Care about Research and Inventory Projects in the Parks?

The First Fire Island National Seashore Science Conference

By Michael Bilecki

Over the past 2½ years, Fire Island National Seashore in New York has hosted several public meetings about various park planning projects. The meetings facilitated good discussion on the issues and also prompted many unanticipated, but welcome, questions about research projects going on in the park. To satisfy this interest in park research, the staff of the seashore decided to hold a public meeting to introduce a few of the research projects just beginning at the park. Despite making announcements in the press, no one attended the meeting–it was a complete flop! This left us wondering if we had gauged correctly the level of interest in science and its application in the park. Perhaps we erred in scheduling it on the island and during the summer when residents and renters are on vacation and relaxing. Also, logistical problems with boat travel for non-island residents may have played into the lack of attendance.

When I discussed the outcome of the meeting with Dr. Mary Foley, Chief Scientist, New England Support Office, she suggested that maybe it was time for Fire Island to hold a science conference. Designed to be more comprehensive than the failed effort, the science conference would introduce both new and ongoing research and inventory projects, from shoreline change to estuary monitoring, and their principal investigators. More summaries would be planned and a direct mailing would publicize the event. We still felt strongly that this would be a good opportunity to show how the data being collected are helping us make various decisions related to resource protection.

Planning the Conference

With so many researchers and grad students conducting research in the seashore, we soon recognized that the conference could last at least 2 days. Because this was to be the first Fire Island National Seashore Science Conference, we decided to start with a 1-day event and focus only on those projects receiving at least some funding from the National Park Service. We ended up with 12 projects from 10 presenters (table 1).

Cost to the park was a concern initially, but ended up being minimal. I spent quite a few hours on the phone discussing topics and the focus of the event with the researchers. Logistics was accomplished efficiently by the resource management staff without spending a great deal of time.

To publicize the event, we created a three-fold brochure-invitation that included a schedule of presentations and mailed it to more than 175 parties using our resource management mailing list. Recipients ranged from individuals with interest in the seashore, home owners, and community associations, to environmental groups, special use groups, universities, and local, state and federal agencies. In contrast with our earlier, failed effort, 80 people signed in at the conference and more than 100 people were counted in the audience.

Impact of the Conference

The conference received rave reviews. Not only did the newspapers print positive stories about it, but the park received a few letters and phone calls from organizations, agencies, and the public telling us how much they appreciated the opportunity to learn more about our work at the seashore.

Perhaps the biggest reason it was well attended was because we targeted invitations and held the conference in January. Also, the presentations were diverse enough to create interest among the many agencies, interest groups, and organizations.

The value of the conference can be measured in various ways. For the park, learning the status of projects and hearing the presentations will be very useful to our inventory and monitoring planning efforts. The most beneficial and exciting aspect from my perspective was bringing the researchers together in one place so that the public, other agencies and resource managers, public officials, and park staff could meet and talk with them. The various groups who attended the conference may not have all agreed with the data or the focus of a research or inventory project, but they did appreciate that the seashore made an effort to share the information and its application in the decision making process.

For their part, the researchers also felt the conference was beneficial. After the conference, Dr. S.S. Mitra (Department of Natural Resources Science, University of Rhode Island) said, "The conference provided a valuable overview of the breadth of scientific research conducted on the national seashore, and it fostered communication among the diverse communities committed to Fire Island's natural resources."

Putting together the conference was not easy, but overall, the organization and preparation were well worth the effort. We hope to make this a biennial event.

Table 1. Presentations at the Fire Island Science Conference

Birds, Mammals, Ticks, and Lyme Disease at the Fire Island Lighthouse Tract
Project Overview and Migratory Bird Phenology and Residence Times
Tick Populations and Transmission Dynamics of Lyme Disease Spirochetes
Tick Burdens and Population Status of Small Mammals and Deer
Contraceptive Management of Fire Island Deer
Density and Herd Composition of White-Tailed Deer Populations
Estuarine Resources: Focus on Nekton Communities
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Michael Bilecki is the Chief of Resource Management and Planning at Fire Island National Seashore; (516) 289-1711; michael_bilecki@nps.gov.

PARK SCIENCE INDEX—1996

ALPHABETICAL BY AUTHOR, PARK, AND KEYWORD

Editor's Note: *Entries pertain to volume 16 (1996) numbers 1-4 (winter, spring, summer, fall, respectively). Issue number is shown in parentheses, followed by page numbers where the article containing the referenced entry can be found.*

1996 Park Science Feature Articles in Summary

BY GENERAL SUBJECT

Ecosystem Management

- The National Park Service took a step toward ecosystem management by participating in an ecological stewardship workshop in Tucson, Arizona **(2)**:13-14. With a book planned as a product, the gathering generated many reflections on the meaning of ecosystem management to this agency **(2)**:15.
- Further evidence that ecosystem management is beginning to come of age was the review of the Keystone Center meeting in Colorado on this holistic management approach **(1)**:10.
- Members of Partners in Flight, the international program for the conservation of neotropical migratory songbirds, convened a workshop in late 1995 and began drafting a conservation plan aimed at building consensus and consistency among the many disparate working groups that make the program fly **(1)**:11,19 (logo, top).
- National Biological Service research scientists Gary Davis and Bill Halvorson released their timely book, *Science and Ecosystem Management in the National Parks,* an argument for the continuation and application of science and monitoring in parks **(2)**:5.

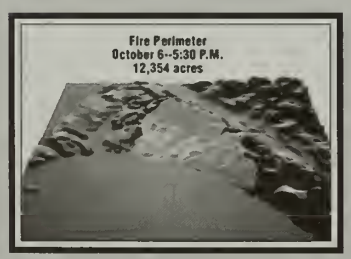
DONNA L. DIFOLCO

Restoration

- Just 3 years after restoring a portion of Kenilworth Marsh in Washington, D.C., park resource managers noted the return of the Long-billed Marsh Wren, a positive indication of corrected wetland function **(4)**:9.
- Lincoln Boyhood National Memorial, Indiana, applied grant funds to an ambitious reforestation project that returned native hardwoods to two meadows near the park visitor center **(4)**:28-29.

Resource Assessment

- Threatened by landslides resulting from over saturated perched aquifers, Hagerman Fossil Beds National Monument, Idaho, undertook a landslide factor assessment procedure to identify likely new areas of impact to fossil resources. Armed with new information, the park established a monitoring program and adjusted their excavation priorities to safeguard the fossils most at risk **(2)**:20-23.
- Hydrologists from the Natural Resource Program Center described a simple field technique for assessing the condition of riparian-wetland areas, the first stage in restoring the proper function of wetlands **(4)**:22-24.



GIS

- Geographic information systems proved invaluable in mapping the fire perimeter, locating and assessing damage to sensitive resources, and tracking restoration efforts during the Vision wildfire at Point Reyes National Seashore, California **(4)**:25-27,29 (bottom photo, left).

Inventory & Monitoring

- Surveys at Gates of the Arctic National Park and Preserve, Alaska, revealed that the candidate threatened plant *Aster yukonsensis* was more common than previously known **(2)**:18-19 (middle photo, left).
- Investigators intensively studied desert rock pool systems in Capitol Reef National Park, Utah. The effort resulted in sound baseline data and knowledge of more than twice as many aquatic species as previously recorded **(3)**:14.
- Researchers at Sleeping Bear Dunes National Lakeshore, Michigan, enumerated many of the problems, issues, and compromises they encountered in maintaining a water quality monitoring program. Among the challenges were continuity in field personnel, gaps in information, and funding for consistent sampling **(3)**:19-21 (top photo, left).

Conferences

- Yellowstone National Park (Wyoming, Montana, and Idaho) hosted a popular conference exploring the ecology and conservation of predatory mammals **(1)**:14-15. The park also convened a 4-day symposium on the biodiversity, ecology, and evolution of hot water organisms where managers, academicians, and biotech companies discussed the contributions to society of biologically diverse, publicly owned resources **(1)**:12-13,19. Similarly, Yellowstone investigated access and property rights to genetic resources at an international conference **(4)**:12-13.
- Held in Boise, Idaho, the Tall Timbers Fire Ecology Conference explored the ongoing shift in the paradigm of fire management from suppression to prescription **(4)**:11,30.

Administrative Adjustments

- Agency restructuring and downsizing shifted resources from central offices to parks, erased familiar planning processes, complicated communication, and reduced technical support; it also increased cooperation in the field, empowered superintendents, and left resource managers pondering how to make the changes work to the benefit of natural resource preservation **(1)**:24-28.
- A National Biological Service ecologist examined the continuing need for science-based management of parks and the dynamic relationship between the National Biological Service and the National Park Service **(2)**:10-12. The report also forecast the merger of the National Biological Service with the U.S. Geological Survey **(2)**:11.

Research

- Research at Apostle Islands National Lakeshore, Wisconsin, pointed to low food availability as a primary cause of reduced bald eagle reproduction in the park and vicinity **(3)**:22-23,26.
- Trampled incessantly by millions of urban park visitors, turfgrass must be matched to the intended use and climate to hold up under these pressures **(3)**:30-31. Research conducted on the National Mall in Washington, D.C., suggested many specific improvements for parks in the use of this utilitarian natural resource **(3)**:27-29.
- Necessitated by road construction, Glacier National Park, Montana, and several cooperators investigated the regenerative capabilities of native conifers and herbaceous species. The information will help the park and a neighboring experimental forest to plan for optimum recovery of native vegetation following such disturbances **(1)**:20-21.

The Scientific Method

- National Park Service contaminant specialists Roy Irwin and Lynnette Stevens pointed out some of the pitfalls of pseudoreplication, a problem not uncommon in ecology research where findings can mistakenly be applied too broadly. Researchers must pay especially close attention to true replication of results in drawing valid conclusions **(2)**:28-31.

Park Science

- An index of *Park Science* articles published in 1995 (like this one) reminded readers of the variety and complexity of natural resource problems we face and the equally innovative solutions matched to the task of resource preservation **(4)**:29-31.
- The MAB Notes column in this publication changed its focus in 1996 from reports on the activities of the Man and the Biosphere National Committee to biosphere reserve parks. Along those lines, the Mammoth Cave Area Biosphere Reserve, Kentucky, reported on its progress with groundwater protection due, in part, to the biosphere reserve designation **(3)**:12-13.

New Techniques

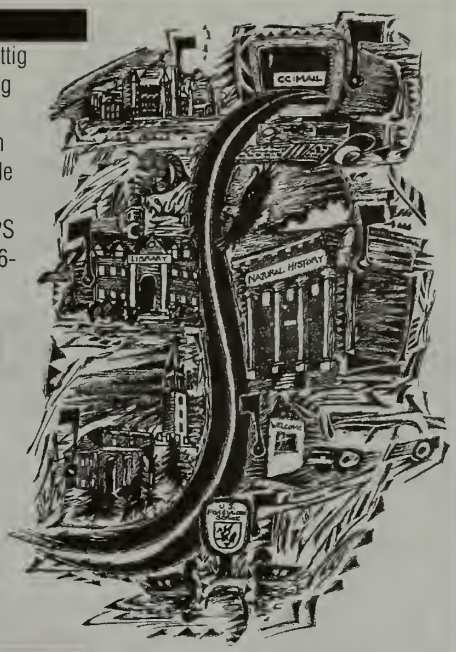
- Cape Cod National Seashore, Massachusetts, shared its experience with FACA, the Federal Advisory Commission Act, and negotiated rule making as resource and visitor management tools to resolve an ongoing contentious issue—off-road vehicle use on park beaches **(2)**:1,16-17,21 (top photo, right).
- The National Park Service tested and adopted a new process for awarding construction project funds based partly on the benefits such work brings to natural resource preservation **(4)**:19-21,30.

Professionalization

- Participants in the Natural Resource Trainee Program of the 1980s and early 1990s spoke out about the positive effect the course had on the professionalization of resource management in the National Park Service **(3)**:1,16-18 (bottom photo, right).

Information Management

- National Park Service biologist Stephen Fettig detailed a method for locating and retrieving biological information over the Internet for users of the NPS cc:Mail e-mail system. An indication of how commonplace World Wide Web technology is becoming, this report seems dated after just one year as more NPS staff connect directly to the Internet **(1)**:1,16-19 (illustration, top).



Economics

- Social scientists detailed a technique for assessing regional economic contributions from national park system units to local area economies **(2)**:24-26. In the hands of a superintendent, this knowledge facilitates better integration of park goals and resource preservation purposes in the planning activities of park gateway communities **(2)**:26-27.

Education

- The rapidly growing *Leave No Trace* program imparts low-impact camping and travel skills and a wildland ethic to park users and provides managers with an educational solution for reducing visitor impacts to natural areas **(3)**:24-26.

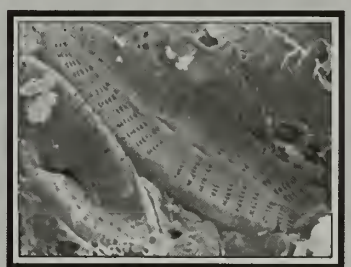
New Information

- Often overlooked in resource management planning and activities, butterflies and moths provide numerous benefits to parks. A survey of northeastern United States national parks, state parks, and national wildlife refuges reflected a growing interest in the management of these insects **(4)**:1,16-18.

Paleontology

- With the help of a scanning electron microscope, researchers journeyed into the micron-sized world of fossil diatoms, redwoods, and sediments that existed 35 million years ago at Florissant Fossil Beds National Monument, Colorado, and revealed a rich geological history of Lake Florissant **(1)**:22-23 (middle photo, right).
- Paleontologists and resource managers at Curecanti National Recreation Area, Colorado, excavated Late Jurassic dinosaur remains little known from the region. The new discoveries thrust paleontological resources into the limelight for this park and increased our knowledge of the distribution of dinosaurs during this time **(4)**:14-15.

PS



Meetings of Interest

SEPTEMBER 20-22 The American Association of Wildlife Veterinarians is sponsoring the workshop, "Wildlife Capture, Immobilization, and Safety," to take place in Fort Collins, Colorado. Topics covered include pharmacology of capture drugs; legalities of drug use; calculating drug doses; handling and care of ungulates, carnivores, and birds; equipment and techniques; and animal and human emergency treatments. The course will include actual immobilization of ungulates at facilities operated by the Colorado Division of Wildlife. For more information, contact Terry Kreeger, Wyoming Game and Fish Department, 2362 Highway 34, Wheatland, WY 82201; (307) 322-4576; tkreeger@uwyo.edu.

SEPTEMBER 21-23 Snowmass, Colorado, will be the venue for the "Forum on Wildlife Telemetry: Innovations, Evaluations, and Research Needs." Topics will include innovations and field evaluations of transmitter and receiving systems and methods, attachment techniques, collection of physiological and environmental data using telemetry, data processing and analysis, and meeting future research needs through telemetry development. For more information, contact Jane Austin or Pam Pietz, USGS Biological Resources Division, Northern Prairie Science Center, 8711 37th Street SE, Jamestown, ND 58401; jane_austin@nbs.gov or pam_pietz@nbs.gov.

OCTOBER 12-14 Yellowstone National Park will host the Fourth Biennial Scientific Conference on the Greater Yellowstone Ecosystem at Mammoth Hot Springs Hotel. Billed as a celebration of the 125th anniversary of the park, the conference has the theme: "People and Place: The Human Experience in Greater Yellowstone." Presentations and panel discussions will explore historical and contemporary perspectives on the ecosystem, including indigenous peoples, rural and urban communities, work and daily life, tourists and tourism, human perceptions of nature, cultural heritage preservation and management, scientific ideas and their impact on park management, the history and philosophy of the national park idea, and others. Details on conference registration, travel, lodging, and camping are now available; contact Joy Perius, Yellowstone Center for Resources, at (307) 344-2209, or look for the World Wide Web site at *http://www.nps.gov/yell/ycr.htm*.

MAY 17-22, 1999 The University of Montana Center for Continuing Education has begun planning for the conference, "Wilderness Science in a Time of Change," to be held in Missoula, Montana. The conference will present research results and synthesize knowledge as it relates to the management of wilderness. Plenary sessions will explore the values of the transactions between science and wilderness; the need to improve the definition of wilderness; and the implications of changing societal definitions of wilderness, increasing technological development, and mounting external pressures. A call for papers will be issued later this year. For more information, contact the Center for Continuing Education at the University of Montana, Missoula, MT 59812; (406) 243-4623 or (888) 254-2544 (toll-free); or ckelly@selway.umt.edu.

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PARK SCIENCE
Integrating Research and Resource Management

Volume 17 National Park Service • U.S. Department of the Interior Number 2

"America's Best Idea"

Preserving Nature in the National Parks: A History

By Richard West Sellars

A book review by Gary E. Davis

THE CONCEPT OF NATIONAL PARKS, SETTING ASIDE UNBROken tracts of land and sea for the enjoyment of people, has been called America's best idea. In *Preserving Nature in the National Parks,* Richard West Sellars meticulously traces the evolution of the national park concept and America's national park system from 1870 to the present. From beginning to end, he confronts readers with evidence that disputes tradition. Among other beliefs, he authoritatively challenges the romantic campfire myth of an altruistic birth of Yellowstone National Park and the national park concept. He offers in its place a pragmatic rationale more consistent with the times. This book is a scholarly presentation of carefully researched and documented facts, woven into an unbroken story.

An insiders view

The tale unfolds from the perspective of the National Park Service, the primary governmental agency responsible for conserving parks. It starts with the campfire myth and nationally known landscape architect Frederick Law Olmsted, Jr., crafting and shaping the National Park Service mission "to conserve the scenery and the natural and historic objects and the wild life [in parks]...unimpaired for the enjoyment of future generations." It ends with the 1993 creation of the National Biological Survey and the sweeping reorganization of the National Park Service in 1995. Throughout, readers get an insider's view of America's favorite government agency. As the story approaches the present, it necessarily shallows to encompass ever more territory, losing its rich historical texture, but gaining a journalistic perspective that serves readers well.

Great new ideas always create tension and elicit vigorous debate. Sellars skillfully draws our attention to a series of tensions created by the national park idea that shaped the concept and its manifestations in the 20th century. Born as a dream of profit from limitless recreational tourism, the creation of national parks was an attempt to resolve the conflict over how to wrest the greatest good and profit from the land: consumption through private exploitation or through public tourism. Sellars also examines the tension between development in parks to facilitate access, lodging, and consumptive recreation versus wilderness preservation. Landscape architects, engineers, and biologists expressed conflicting interpretations of "unimpaired" during the 1920s and 1930s. This tension has evolved into a continuing discussion of scenery or façade versus ecosystem management.

Clearly, early promoters of national parks had no qualms about developing facilities in parks and consuming park resources. In promoting creation of the National Park Service in 1916, Robert Sterling Yard wrote in *The Nation's Business,* "We want our national parks developed....We want good fishing. We want our wild animal life conserved and developed." The first two directors of the National Park Service, businessman Stephen Mather and lawyer Horace Albright, both believed the public needed to be enticed into parks with roads, lodges, and enhanced fishing, in addition to the park's scenery and other natural assets. They set about

Continued on page 8

PARK SCIENCE

Integrating Research and Resource Management

Volume 17 — No. 2 • November 1997

PUBLISHED BY
The National Park Service
U.S. Department of the Interior

DIRECTOR
Robert Stanton

ASSOCIATE DIRECTOR, NATURAL RESOURCE STEWARDSHIP AND SCIENCE
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Park Science (ISSN-0735-9462) is a quarterly science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations–materials do not undergo refereed peer review. *Park Science* is also available online (ISSN-1090-9966) at *http://www.aqd.nps.gov/nrid/parksci*.

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to the National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Please refer to guidelines published in volume 16(3):5-6 and online, or contact the editor:

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Printed on recycled paper

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DEPARTMENTS

FEATURES

IN THE NEXT ISSUE. . .

Social scientists Sarah Flick and Jonathan Taylor review their research on the attitudes of backpackers and day visitors in Rocky Mountain National Park.

LESSONS IN HISTORY

A BOOK REVIEW IS UNUSUAL TO FEATURE AS A COVER STORY IN *PARK SCIENCE*. YET "Preserving Nature in the National Parks" by Richard Sellars is not an ordinary book. A study in the management of nature in the national parks, this work examines our record, inconsistent at best, in embracing science as a management tool over the past 125 years. Although biologists such as George Wright, Adolph Murie, and A. Starker Leopold advanced the notion that management of park resources requires a scientific approach, the book shows that the Park Service has been very reluctant to embrace scientific management since this was first promoted by Wright in the early 1930s. What we have been good at doing, Sellars details, is developing parks for visitor enjoyment, a tradition in park management with deep roots, extending back into the nineteenth century. Have we become prisoners of this success? Can we change? "Preserving Nature" is a fine historical basis for discussion of these questions; to be sure, it reminds us that natural resource management based on unsubstantiated beliefs comes with high ecological costs.

Park Science was inaugurated 17 years ago to address some of the same concerns analyzed in Sellars' book. The stories published in these pages are testimony that science in management is indeed a reality in parks today. However, we must further this union and increase our application of science in the parks if we intend to meet the vast resource preservation tasks at hand. Sellars' historical account may help elevate the role of science in management by presenting us with a clear analysis of the past. We will continue to do our part by publishing good examples of the application of research in management.

Jeff

Omission

Last issue, we featured our annual index of articles published in volume 16 (1996). This index would not be possible without the help of the Columbia-Cascades Support Office. Each year, library volunteer Edith Miller indexes the articles and Richard Aroksaar, an automation librarian, automates the index for electronic distribution. Most recently, Aroksaar created a Windows help file of all 16 volumes that can be downloaded from the *Park Science* web site at *http://www.aqd.nps.gov/nrid/parksci/citation.htm*. The help file is easy to search for article title, author, keyword, or park code. On behalf of our readers, I want to thank Ms. Miller and Mr. Aroksaar for their help in providing this important service.

Editor

Web address change

The *Park Science* web address has changed once again. It is now simpler than before–*http://www.aqd.nps.gov/nrid/parksci/*.

Natural resource stewards honored

Two resource managers, a researcher, a park superintendent, and an exhibit specialist were honored among their peers last summer at three different awards ceremonies as recipients of the prestigious Director's Awards for Resource Stewardship for 1996. All winners were recognized for their outstanding contributions to technical expertise, continuity, and innovative thinking in research and resource management.

Gary Davis, Senior Scientist and Research Marine Biologist at Channel Islands National Park, California, was given the 1996 Director's Award for Natural Resource Research. Davis is a champion of ecological monitoring and scientifically based ecosystem management. He has shown these strategies to be reliable and cost effective and has developed monitoring protocols used widely by others. He is an inspiration among colleagues and a mentor of young scientists. His research, which has contributed to marine conservation in the Caribbean, Florida, and California, has explored the role of maritime parks as refugia to sustain and restore coastal fisheries and protect biodiversity. Davis is also a leader and has served as president of the American Academy of Underwater Sciences and the George Wright Society; he was a board member of the Natural Areas Association. He returned to the National Park Service recently after serving with the USGS Biological Resources Division, California Science Center, since 1993. His research insights and broad understanding of marine resources have been very valuable assets to the National Park Service and the Biological Resources Division. "To be recognized among peers feels good," Davis said. "These awards remind us all of what a job well done looks like."

Gary Davis

The 1996 Director's Award For Natural Resource Management was awarded to Ken Czarnowski, Hydrologist at Rocky Mountain National Park, Colorado. Through his creativity and persistence, Czarnowski has resolved numerous complex natural resource issues at the park, primarily those dealing with water rights. For example, he negotiated with the Bureau of Reclamation and other parties to redirect water back into a park drainage, providing for natural park processes and restoring a high altitude park wetland. Working with the Department of the Interior Office of the Solicitor, the Department of Justice, and the NPS Water Resources Division, Czarnowski developed agreements to protect the park from future litigation on water issues. Additionally, Czarnowski's broad understanding of park resources, negotiation skills, and ability to work with attorneys and technical staff from other agencies have helped to address aircraft overflight issues at the park.

Alan O'Neill

Winning the 1996 Director's Award for Superintendent of the Year for Natural Resource Stewardship was Alan O'Neill of Lake Mead National Recreation Area. O'Neill is a visionary who has built a professional resource management program at the Arizona-Nevada park. His commitment to resource protection is evident from his support of the park's burro management program, the razorback sucker recovery plan, and the federally listed desert tortoise habitat protection endeavor. O'Neill also excels as a leader. He helped bring together numerous partners during the initial phases of the California Desert Ecosystem Management Initiative, a complex interagency framework for managing over 25 million acres of public lands. As chairman of the Pacific-West Region resource management and science task force, he leads by example, providing support to parks engaged in strategic planning efforts. His leadership has enhanced the NPS role in cooperative ecosystem management and sets an excellent example for all land managers.

Ken Czarnowski

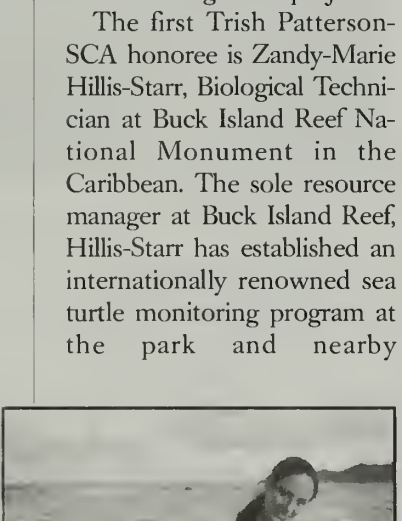
For the first time, the Director's awards included the Trish Patterson-SCA Award, which recognizes excellence in natural resource management in small parks, where staff are often especially limited.

Continued on page 4

Continued from page 3

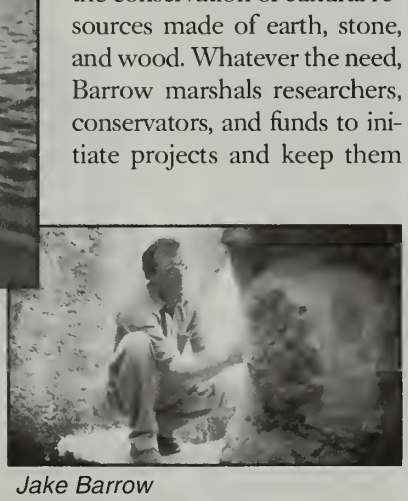
Patterson was a Southeast Region resource manager who died in a 1995 car accident; she was well known for her efforts to assist small parks in her region. Sponsored by the Student Conservation Association, the award provides extra assistance to the winning park by supplying a seasonal resource assistant to help complete important resource management projects.

The first Trish Patterson-SCA honoree is Zandy-Marie Hillis-Starr, Biological Technician at Buck Island Reef National Monument in the Caribbean. The sole resource manager at Buck Island Reef, Hillis-Starr has established an internationally renowned sea turtle monitoring program at the park and nearby Christiansted National Historic Site; she also has established coral reef monitoring at Buck Island Reef. Her preparation of the Buck Island Hawksbill Turtle Research Program Manual has served to standardize data collection methods for endangered turtles and reef monitoring. Information derived from the sea turtle program has been used to protect the hawksbill sea turtle under the Endangered Species Act. With a knack for getting things done, Hillis-Starr instituted a program with volunteers and visiting scientists to document the effects of Hurricane Hugo (1989) and monitor subsequent reef recovery. She also arranged cooperative agreements with government and private organizations to assist in reef and turtle projects.



Zandy-Marie Hillis-Starr

The Ray E. Appleman-Henry A. Judd Award, which recognizes achievement in cultural resource management, went to Jake Barrow, a Supervisory Exhibit Specialist with the Intermountain Cultural Research Center in Santa Fe, New Mexico. Barrow has been instrumental in several multiyear projects to conserve historic structures at Fort Union National Monument and Hot Springs National Park and other cultural resources in the Southwest. His efforts have advanced the conservation of cultural resources made of earth, stone, and wood. Whatever the need, Barrow marshals researchers, conservators, and funds to initiate projects and keep them going until completion. In almost every case, the lessons learned at one site are applicable elsewhere. PS



Jake Barrow

GULF COAST

Oil and gas collaboration a success

Padre Island National Seashore, Texas, completed a successful collaboration with the Railroad Commission of Texas in November 1996, culminating three years of effort to bring a leaking gas well under compliance with NPS nonfederal oil and gas rights regulations. The well operator's lack of diligence prompted growing concern about navigational safety and potential environmental degradation at the park. As a result, the park filed a complaint to the state about the well, which is located in the Laguna Madre, a shallow, hyper-saline water area of the park noted for its extensive seagrass beds, productive fishery, and migratory bird rookeries.

The Railroad Commission, the state agency that administers the statewide oil and gas production and permitting program, prompted the operator to comply with state oil and gas rules and pollution prevention laws. But when the operator failed to respond, the commission held an administrative hearing in June 1995 to determine appropriate penalties. Linda Dansby, the Intermountain Region Minerals/Oil and Gas Program Leader, assisted Paul Eubank, Environmental Protection Specialist at the park, to prepare the NPS statement for the hearing. Held before a legal and technical examiner, the hearing resolved the issue, and the Railroad Commission ordered the well plugged and fined the operator $3,000. Subsequently, the commission plugged the well and bore the cost of $120,000.

The remote location of the well, shallow waters of the lagoon, and seagrass beds contributed to the complexity of plugging this well. Mr. Tim McGilvary of the San Antonio office of the Railroad Commission coordinated the project. His professional expertise and close communication with the park resulted in identifying access and resource issues, and developing innovative methods, such as using air boats to bring the plugging rig to the well. The well was plugged in November 1996 without impacting ecologically important seagrass beds.

In May 1997, the Railroad Commission continued its work with the National Park Service by using the same oil and gas rules and fund for plugging wells to seal an abandoned oil well at Big Thicket National Preserve. The inactive oil well was the subject of a complaint filed by the park in 1995, and the commission notified the operator to plug the well. The park monitored the site and documented that the operator had failed to take action. Later, the Railroad Commission plugged the well, at a cost of $8,000, and also removed salvageable oil field equipment. The park's skill in applying NPS regulations along with state oil and gas rules, maximized their ability to develop a partnership with the Railroad Commission of Texas toward a common goal of protecting park resources.

ALASKA

Ecosystem partnership formed

Working closely with the Biological Resources Division of the U.S. Geological Survey (BRD), Wrangell-St. Elias Na-

tional Park and Preserve has helped form the Prince William Sound-Copper River Natural and Cultural Resources Cooperative, an ecosystem partnership. The cooperative includes the primary federal, state, and native resource managers for the ecoregion. The park has led the cooperative in the realm of geographic information systems by sponsoring training and providing spatial data sets to cooperative members.

Participation in the cooperative has strengthened the relationship between the park and the BRD. The cooperative has also helped depolarize formerly troublesome relationships between some of the partners. This improvement in relationships paves the way for cooperation to address the priority issues for Wrangell-St. Elias and the region–burgeoning tourism and a catastrophic spruce beetle infestation that has killed trees on more than 600,000 acres (an area the size of Rhode Island).

• • •

Whale photo catalog no fluke

Researchers Chris Gabriele of Glacier Bay National Park and Preserve and Jan Straley of

R BAY NATIONAL PARK & PRESERVE; CHRIS GABRIELE

le #117—"White Eyes"

the University of Alaska Southeast (Sitka) will be publishing in December a catalog of southeastern Alaska humpback whale "mug-shots." Individual humpback whales can be identified by the coloration, shape, and scarring of the ventral surface (belly side) of their tail flukes. Released in both hard copy and on a series of CD-ROM discs, the images show the tails of some 1,110 humpbacks identified in southeastern Alaska between 1986 and 1996. Each fluke identification photograph is indexed and corresponds to sighting data for that individual that is contained in a companion database. Together, the sighting data and photographs will help the researchers learn more about reproduction and recruitment of the humpback whale in southeastern Alaska.

The partners secured funding last year for the project through the NPS Challenge Cost Share Program. In October 1996, the humpback whale researchers began gathering sighting data and organizing the photographic catalog. "We are very enthusiastic about the potential uses of the sighting history database," Gabriele said, "because it will allow us to document the movement of whales throughout southeastern Alaska. In particular, we will use it to compile the reproductive histories of southeastern Alaska female humpbacks and the return of their young to the study areas." Humpback whales have strong site fidelity to their feeding areas, with calves returning to the same places where their mothers took them to feed in their first year of life. Thirty-six calves have been identified in the Glacier Bay area, and park staff have documented the return of 16 of them, including one female who returned with her first calf at age eight. The eventual recruitment of individuals as breeding adults is a vital component of the future health of the population.

The researchers plan to update the photo catalog and sighting information database annually. The photo catalog will be distributed to local charter boat operators to help them recognize whales seen out on the water. The database and catalog will be circulated to colleagues to facilitate collaborative research on the behavior, migrations, and biology of the species throughout the North Pacific. A number of catalogs will be also be made available to the public. For more information, contact Gabriele at *chris_gabriele@nps.gov.*

SOUTHWEST

El Malpais reclaims sandstone quarry

Students from New Mexico Highlands University kicked off a large-scale project last April to reclaim an abandoned sandstone mine at El Malpais National Monument when they salvaged 150 plants for later use in revegetating the disturbed site. The 5-acre quarry, which is located in the southeast portion of the park, was a safety hazard and blemish in the scenic landscape. The park spent nearly a year planning the project, which involves the help of the NPS Geologic Resources Division and Southwest Support Office, U.S. Army Reserve, the university, and other partners.

In July, Army Reserve engineering units from Santa Fe and Albuquerque began moving earth to reduce the 30-foot high walls of the quarry and recontour the pit to blend in with the surrounding area. The same crews also constructed a wayside exhibit and viewing area for McCarty's Crater and the distant chain of craters, important volcanic features of the park. Additional park improvements were undertaken at the same time and include construction of a road to an existing trailhead (Lava Falls), removal of an eroding road, and removal of water impoundments.

The project has been very cost-effective for the National Park Service, and all partners have benefitted from the experience. The NPS Geologic Resources Division funded on-site technical support for the earthmoving phase of the project and paid for diesel fuel for the heavy equipment. The Army Reserve donated staff time and equipment in exchange for a practical field training exercise. The students, who

GEOLOGIC RESOURCES DIVISION, DAVE STEENSEN

An Army Reserve bulldozer recontours the sandstone quarry at El Malpais National Monument

collected plants from the site for later use in the revegetation phase, receive credit to meet undergraduate degree requirements in biology and environmental science and management. Some of the materials used in preserving the native plants were donated by a local company, Santa Fe Greenhouses. Revegetation will be completed this fall and topsoil will be added to the quarry next spring. PS

Electronic journal launched

The Ecological Society of America recently launched *Conservation Ecology,* an electronic, peer-reviewed, scientific journal that is available on the World Wide Web at http://www.consecol.org/Journal. Editor-in-Chief C.S. Holling writes in his inaugural editorial that the publication does not focus on traditional ecological research, but interdisciplinary communication and insight. This "is a new journal covering a new application of science, using a new medium. It requires novelty and experiment."

Papers are organized around the themes of synthesis, research, insight, and perspective. They deal with the topics of (1) the conservation of ecosystems, landscapes, species, populations, and genetic diversity; (2) the restoration of ecosystems; and (3) the management of resources. Articles are posted continuously and new issues of the publication are declared semiannually or as adequate materials accumulate.

One especially interesting feature of the first issue of the electronic journal is the discussion of the role of ecology in shaping management policy. One paper explores the problems managers have today with traditional descriptive ecology, which does little to address system dynamics at meaningful scales, while seven additional commentaries enrich and challenge that view. A sampling of other articles includes the resilience and restoration of lakes; the relation between threatened species, their protection, and taboos; and using ants as bioindicators. An electronic public forum is also available to facilitate discussion among readers.

Conservation Ecology already boasts 5,000 subscribers and is a great forum for the exchange of ideas on the application of ecology in resource management. Access to the Internet publication and e-mail subscriptions are free of charge. To subscribe send an e-mail message to *subscribe@consecol.org* containing only "subscribe conservation-ecology" in the body of the text. Prospective authors will also find article submission instructions by visiting the web site.

Paleontology publication planned

Researchers in the paleontology of national parks now have an opportunity to publish their most recent work in the upcoming third volume of National Park Service Paleontological Research. With earlier versions appearing in 1993 and 1995, this nonpeer-reviewed publication features brief accounts (5-6 page mini papers) of recent original paleontological research occurring within units of the national park system. Vincent Santucci, Resource Management Specialist and paleontologist at Fossil Butte National Monument, Wyoming, will serve as editor and is now soliciting titles for the volume. Interested contributors should submit their titles to Santucci by December 15 at (307) 877-4455; *vincent_santucci@nps.gov.* According to Santucci, "A collective work such as this illustrates the diverse and often cutting-edge research going on in parks. It demonstrates our appreciation of the efforts of paleontology researchers and will help foster future work." The publication is sponsored by the NPS Geologic Resources Division.

New angle on kudzu control

A September 7 article by Rick Bragg in the *New York Times* described a new biological control effort to fight the "legendary weed" kudzu. Originally from Asia, kudzu has evaded ecologically safe and effective control in the Southeastern United States for more than 50 years and is a problem in numerous units of the national park system. In research funded by the U.S. Forest Service and the Department of Energy, North Carolina University researchers are introducing a caterpillar, the soybean looper, into kudzu fields. The insect eats the kudzu and subsequently dies from wasp larvae previously injected into them. The Forest Service may test the strategy in remote areas of national forests where heavy equipment or herbicides are a threat to other organisms.

Old problem, new solution?

Park visitors will always feed wildlife to some extent, and rangers will always grapple with finding the best deterrent. However, a photo processor in Banff National Park in Alberta, Canada, has discovered a novel approach to addressing the age-old problem. The September issue of *National Geographic* reports that an "exasperated photo shop manager" began including warnings on his clients' photos when the images depicted the unsafe and illegal behavior of a person feeding park wildlife. Parks Canada followed suit by printing 40,000 cards that several photo processors now distribute on their behalf whenever these kinds of pictures are processed. The cards depict the international symbol– ⃠ –printed over pictures of people feeding several kinds of animals; they are printed in four languages and carry the message, "A Fed Animal is a Dead Animal." The park reports a positive response and plans also to place the cards in hotel literature.

I&M Program releases first annual report

The first comprehensive annual report of the Inventory and Monitoring Program is available on the Internet at *http://www.aqd.nps.gov/pubs/i&mann96/cover.htm.* Hard copies are also now available. The five major parts of the report describe the parks where prototype monitoring is being developed; provide summaries of inventories of soil mapping, vegetation mapping, geologic mapping, base cartographic data, bibliographic databases, and water quality; give accounts of various resources in the parks, including glaciers, aquatic and terrestrial communities, forest insects and diseases, listed species, fishes, birds, mammals, and others; and briefly describe data management in the program and the I&M Training Program. The report gives readers good insight into the many threats to natural resources in the national park [illegible].

Logging and the abundance of Northwest fishes

Logging of a riparian forest usually reduces the rate of deposit of large woody debris into a stream. Debris depletion of this kind continues during times of little or no deposits, which can cause a net decline for several decades and a sustained low amount of debris for 50-100 years after logging. In their 1997 paper, "Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams" (*Transactions of the American Fisheries Society* 126:217-229), authors T.J. Beeche and T.H. Sibley describe many of the ecological effects associated with the loss of this debris for certain species of fish in the Northwest.

Large woody debris forms pools in streams, and pools retain sediment and particulate organic matter. Woody debris therefore can influence the distribution and abundance of juvenile salmonids in streams because such pools are preferred habitat of, for example, juvenile coho salmon *(Oncorhynchus kisutch),* cutthroat trout *(O. clarki),* and steelhead *(O. mykiss).*

In accordance with their findings, the authors predict declines in number and area of pools in channels of low and moderate slopes but greater declines in moderate-slope channels than in low-slope channels. The decline in pools may favor species that are better suited to rearing in riffle environments, such as steelhead, and may lower the abundance of species or age classes with strong preferences for pools. Changes would be greater in moderate-slope channels. The authors provide suggestions for management of riparian forests to offset the effects of reduced large woody debris from logging.

USGS water resources software on the Web

A suite of 51 software packages and related materials, used by the U.S. Geological Survey for hydrologic analysis and modeling, is now available for electronic retrieval through an online repository on the World Wide Web. The repository is accessible at *http://water.usgs.gov/software/* and can also be retrieved via anonymous FTP from the USGS water resources information fileserver: *water.usgs.gov or 130.11.50.175* (path: pub/software). The software is grouped into the categories of geochemical, groundwater, surface water, water quality, and general. Each package consists of compiled or source code, test data sets, and documentation files. All of the USGS water resources, hydrologic analysis, and modeling software applications available publicly at these locations are documented by published USGS reports.

The software packages have been prepared primarily for the Data General AViiON DG/UX platform and for compilation on other UNIX-based computers. The USGS continues to prepare software packages for its own use on UNIX-based and other computer platforms such as DOS-based personal computers. As these packages are available, they will be added to the repository.

Integrated pest management and the white-tailed deer

Densities of white-tailed deer have increased to probably the highest recorded levels in the eastern United States. The distribution of the species across its former range may also have changed drastically. These changes are probably attributable to fragmentation of habitat, creation of urban greenbelts, spatial changes in agricultural landscapes, changes in availability and types of agricultural crops, restrictions of hunting season and bag limits, elimination or reduction of lands for hunting, and predator control. In their 1997 paper, "A planning process for managing white-tailed deer in protected areas: integrated pest management" (*Wildlife Society Bulletin* 25(2):433-439), NPS biologists Michael A. Coffey and Gary .H. Johnston discuss how the integrity of protected areas (such as parks) may be impaired by the density of a deer population, and that hands-on management may be necessary. The authors promote integrated pest management that is based on (1) clear, precise goals and objectives, (2) problem identification, (3) and the development and implementation of scientifically valid monitoring. The authors provide alternative management, a decision key that assists managers with the completion of specific and necessary actions, and an alternative key that provides alternatives ranging from those with the least ecological, economic, sociological, and political effects to those that are most difficult to implement.

Grouse papers published

University of Maine CPSU Leader Allan O'Connell wrote about the effects of fragmented landscapes on the management of Spruce Grouse in Acadia National Park in *Park Science* 15(3):10-11. He is now coauthor of two manuscripts about the ecology of a small population of Spruce Grouse with respect to habitat fragmentation in the Northeast. The citations are:

Whitcomb, S.D., A.F. O'Connell, Jr., and F.A. Servello. 1996. Productivity of the Spruce Grouse at the southeastern limit of its range. Journal of Field Ornithology 67(3):422-427.

Whitcomb, S.D., F.A. Servello, A.F. O'Connell, Jr. 1996. Patch occupancy and dispersal of Spruce Grouse on the edge of its range in Maine. Canadian Journal of Zoology 74:1951-1955.

Spruce Grouse

Preserving Nature continued from cover

building facilities, including fish hatcheries, and planting alien fish in parks as their first order of business for the new agency. They also believed they should "enhance" the parks by suppressing fires, eradicating predators, and controlling forest pests and diseases, which they did vigorously.

Scientists, managers clash

At its inception, national park management was a new human endeavor. No one before had tried to preserve intact large tracts of wild land and seascapes for public enjoyment and to pass them on to future generations. Unlike forest and fisheries management that had centuries of precedent and practice, what park managers needed to do had no precedent. They were truly exploring the unknown and relied on extant professions for guidance. Foresters, landscape architects, and engineers who used land to produce commodities and who molded landscapes to fit human perceptions of idyllic and pastoral settings came the closest to fitting the new paradigm so they got the job: directed by businessmen and lawyers. However, national park management is more than a simple combination of these early professions, it also requires applied sciences, particularly ecology. Adding ecologists to this mix, was like combining oil and water. We are still looking for an emulsification agent.

Sellars makes it clear that the tension between scientists and nonscientists regarding national park management was the same in the 1930s as it is today. In part, the differences arise from nonscientists relying on untestable, belief-based consensus versus scientists adhering to a testable knowledge-based system of learning from experience. If one believes that fire destroys forests, or that wolves threaten elk populations, there is no reason to waste time and money testing the concepts. One simply acts on his beliefs and suppresses fire and kills wolves. Testing such beliefs threatens the belief and the believers, and thus creates a perception that science would make park management more costly, difficult, and time consuming. This may be at the root of the issue that creates the tension between so-called traditional and ecological approaches to park stewardship.

Science as a way of knowing should make attaining the National Park Service mission more certain and cost effective. The true costs of ecological restoration and of losing America's heritage to unfounded beliefs are vastly greater than the costs associated with learning first how ecosystems work and doing the job right the first time. We paid dearly for early misguided forest fire suppression. First we paid the unnecessary costs of suppression. Now we are paying the costs of restoring fire, with the risk of losing the very assets we sought to protect if we delay any longer. We paid to eradicate wolves and other predators, then paid to reduce elk and deer, lost soil and vegetation, and now we must pay to restore wolf populations. This kind of cost dwarfs the minimal costs of using science to learn what is in parks, how to restore impaired assets, how to maintain restored parks, and how to protect parks from pollution, unsustainable uses, fragmentation, and alien species. In short, using science to learn from our experience reduces uncertainty and costs.

In the last century, the parks could afford the boosterism, "enhancements," and facilities of Mather and Albright and still recover, because parks were not the islands in a fragmented and diminished landscape that they are today. Few refugia exist today, outside legislated wilderness, from which to find replacement genomes and species to repair the damage wrought by misguided policies. We are already beginning to lose our heritage in the marine environment where we have no wilderness, no refugia, and denial of human impact is rampant even in the national park system. Time is short. Options to conserve and pass on unimpaired parks to future generations become more limited every year.

Preserving Nature

Yale University Press

New Haven, Connecticut

364 pages

$35.00 (hard cover; ISBN 0-300-06931-6)

Contact: Jim Stritch (203) 432-0939

Will history repeat itself?

Change is inevitable. Will we use science to learn from experience, or continue to blindly accept and act on unsubstantiated beliefs? The National Park Service will not accept a change from its primary goal of recreational tourism to science-guided resources protection until its leaders personally experience success with science. As a result, people such as Richard Sellars run great risk of being attacked by opponents vested in the old system and only moderately supported by skeptics of the new, science-based system. Since the national park concept is new and unique, few have the necessary personal experience, yet. Perhaps the introspection in this book will lead to trying new ways to conserve parks.

In interpretive jargon, scenery is the hook. Once enticed into in the parks by the scenery, the public can personally experience the wonders they contain, beyond the view. Mather and Albright believed they had to entice the public to visit parks and to support the park concept. The National Park Service did that during the 20th century. The public has found and loves their park system and the National Park Service. Now the hard work begins–learning what is in the parks and how they work, restoring impaired assets, maintaining impaired processes, and protecting parks as islands of wilderness in a landscape dominated by human activities.

Until we learn our history, how we came to where we are, and where we thought we were going, we risk endlessly repeating the same mistakes. This account illuminates our path. Read it. You will like it. You may not agree with everything in it, but you will learn from it. We and our national parks will all be the better for it. PS

The true costs of ecological restoration ... are vastly greater than the costs associated with learning first how ecosystems work and doing the job right the first time

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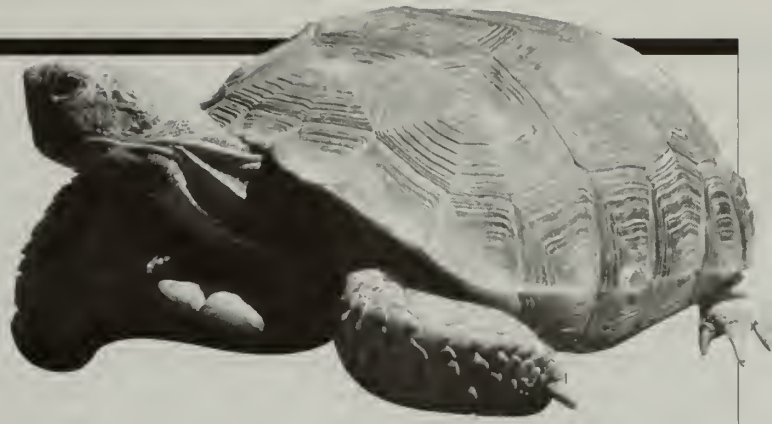
The Desert Tortoise in the Mojave Desert Parks

A preliminary research update



By Michael Boyles and Jerry Freilich

Few reptiles of the desert southwest garner as much attention as the desert tortoise *(Gopherus agassizzii)*. Unfortunately, one reason for this attention is the dramatic decline of tortoise populations throughout a large portion of the species' range (U.S. Fish and Wildlife Service 1994). Reductions of up to 20% per year have been reported (U.S. Fish and Wildlife Service 1994), causing alarm within the biological community. Reasons for the decline are not completely understood, but urban development, off-road vehicle use, livestock grazing, poaching, increased predation by common ravens *(Corvus corax)*, and a recently discovered upper respiratory disease are likely contributing factors (U.S. Fish and Wildlife Service 1994). In 1990, the U.S. Fish and Wildlife Service listed as threatened the entire Mojave Desert population (fig. 1), defined as all individuals north and west of the Colorado River. The Sonoran population, south and east of the river, remains a candidate for listing as a threatened species.

Research by parks

Within national parks, the desert tortoise is protected from many of the human influences that may be causing its decline. Parks serve as a control framework with which to evaluate declines elsewhere in the species' range. For example, if the tortoise is declining due to direct human factors, these declines are less likely to be seen in parks. If declines are observed in parks, the causes may be attributable to influences not limited by park boundaries, such as atmospheric or global effects. Tortoise research in parks may help elucidate other, as yet unknown, factors that contribute to the decline of tortoise populations.

The role of the National Park Service in managing the desert tortoise regionally expanded in 1994 with the initiation of a three-year research project funded by the Natural Resources Protection Program (NRPP). One of the main objectives was to implement several of the recommendations in the 1994 Desert Tortoise Recovery Plan to protect the tortoise and its habitat and ensure future viable populations throughout the southwestern deserts. These recommendations include surveys to determine the location and density of tortoises; establishing long-term monitoring plots; improvement, restoration, and protection of habitat; and strengthening public awareness and environmental education.

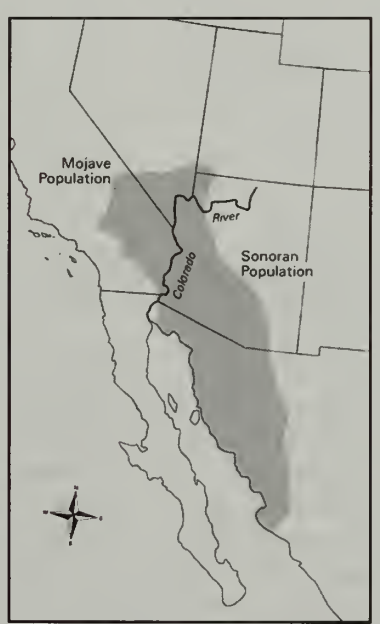


Figure 1. The threatened Mojave population of the desert tortoise occurs north and west of the Colorado River, while the Sonoran population lies south and east. Interestingly, the boundary between the two populations bisects Lake Mead National Recreation Area.

Five parks are participating in the research: Lake Mead National Recreation Area, Nevada and Arizona; Joshua Tree and Death Valley National Parks, California; and Organ Pipe Cactus National Monument and Saguaro National Park, Arizona. Staff from each of these parks assisted in the design and establishment of the study. However, because the extent of information and research on the tortoise varied considerably among the parks at the onset of the study, each park developed its own study design.

Life history of the desert tortoise

Research and monitoring of the desert tortoise is difficult because of the species' unusual life history. The reptile is adapted to living in a harsh and variable environment. It retreats into burrows and reduces its metabolism during periods of adverse environmental conditions. Thus, it spends much of its life underground, hibernating during the winter and escaping from the hot temperatures of summer (Woodbury and Hardy 1948). Its active period is largely confined to the mild spring and fall, and even at these times, it may reduce its activity if the season is unusually extreme as during the recent drought in the Mojave Desert. Thus, biologists must concentrate their efforts into a few months for any research that requires seeing the animals above ground.

The longevity and reproductive strategy of the tortoise also complicate monitoring. With a potential life span of many decades, the desert tortoise can compensate for variable reproductive success by breeding many times throughout its life, and one year of reproductive success may offset several years of failure. In order to

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Desert Tortoise continued from page 9

get a realistic idea of population trends, biologists must not only make an accurate determination of population size (a difficult task in itself), but also follow population recruitment for many years (Doak et al. 1994). One year of successful reproduction is no more indicative of population recovery than several years of reproductive failure is of extinction.

Transects and plots established at Lake Mead

At Lake Mead National Recreation Area, we have established 14 1-km^2 (247-acre) study plots over three years to begin population monitoring. In addition to the plots, we have also established over 400 1.5-mile triangular transects in which biologists identify tortoise habitat and map tortoise distribution (fig. 2). Transects and plots are separate techniques that provide us with different types of information. Transects involve a single visit to a site in which biologists look for live tortoises, burrows, scat, and shell remains. The findings give us a preliminary idea of relative tortoise population density, and by spreading the transects across the park's 1.3 million terrestrial acres, a once patchy notion of tortoise distribution has become more complete. Plots, on the other hand, provide a way to monitor a localized group of tortoises for a long period of time. By making repeated visits to a plot and conducting intensive searches for tortoises and other sign, we can collect valuable ecological and life history data on the animals. Over the long term, this information may allow us to determine population trends, if only at a very localized scale.

Our transect work was highly successful in helping us determine which areas of the park contain desert tortoises. The 400 transects surveyed translate into roughly 960 km (600 mi) of surveyed ground. While most of Lake Mead's terrestrial acreage could be considered potential tortoise habitat, distribution of the animals is quite patchy. A few "hot spots" of high tortoise density have been found, as have several medium-density areas. Still other areas of the park show little or no evidence of tortoise occupation, even in what appears to be suitable habitat.

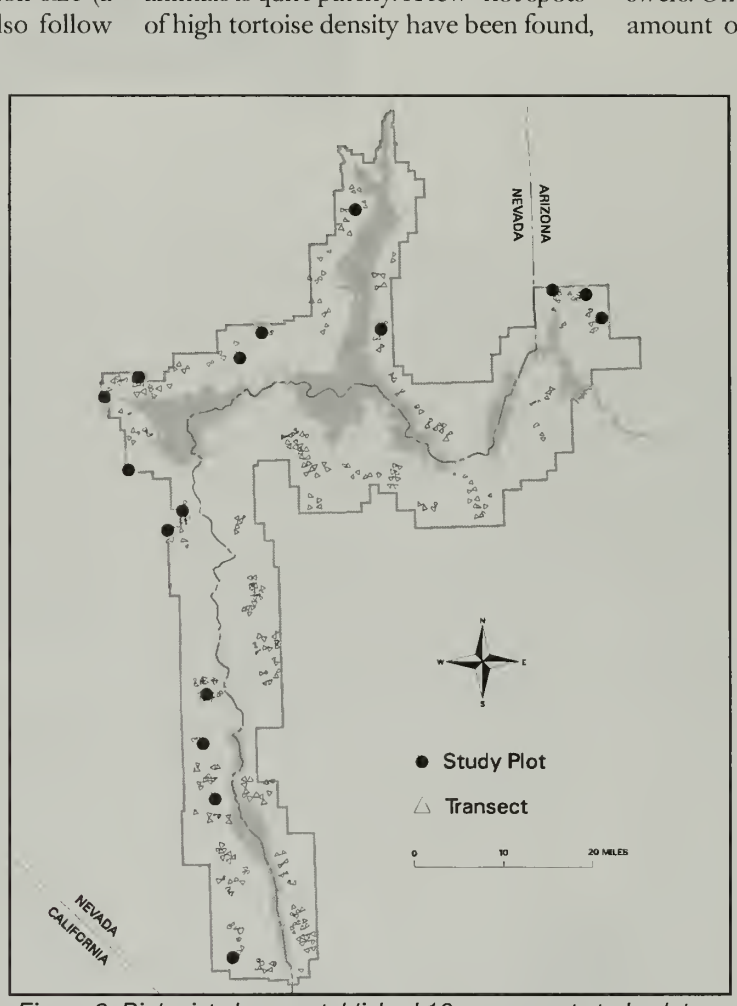

Figure 2. Biologists have established 16 permanent study plots and over 400 1.5-mile triangular transects in Lake Mead National Recreation Area to learn about tortoise distribution.

From our work on plots, we have established a baseline data set that we can follow for years. All tortoises found on the plots have been permanently marked. Thus, future sightings of these individuals will provide data on survival and movement patterns. Even as the NRPP project draws to a close, we have plans to extend our work and continue adding to our rapidly growing database.

Limitations arise

Where the transect monitoring method has provided new information about tortoise distribution, plot monitoring has posed at least as many questions as answers. One problem is the relatively short amount of time spent monitoring each plot. Our method consists of inventorying the plots within a series of parallel, 10-m (33 ft) wide transects (fig. 3). Because of such a short window of tortoise activity in the spring, we must concentrate our work into a 10-week period. During this time, biologists make two four-day passes over each plot for a total of eight days of sampling per plot. Do these days adequately represent the spring activity season? If not, the number of tortoises observed may differ greatly between the two passes, which makes population estimates based on this particular mark-recapture technique extremely difficult.

All plot-based methods suffer from the problem of limited inference. While intensive effort on a plot may lead to robust density estimates and can possibly identify certain population trends, the results of such efforts are site-specific and do not necessarily indicate what is happening regionally. As with any threatened species, the critical need is for information on the temporal and spatial trends of population abundance over the entire range of the species' habitat. Plot monitoring is time consuming, requires repeated visits, and is not likely to provide this information.

Monitoring methods pioneered at Joshua Tree

At Joshua Tree National Park, we also dealt with some of these issues and found that years of data proved invaluable in helping determine the preferable method of studying tortoises. Beginning in 1991, before the NRPP study, we spent four years monitoring tortoises in a known hot spot (the Barrow site) and 12 other plots.

ure 3. Biologists use GPS (global sitioning systems) units to record tortoise ations within the study plots.

For the first few years, we found many new tortoises during each survey, suggesting that tortoises are easily missed by biologists. Initially, we were not sure if this was due to tortoises hiding underground or moving in and out of the study area. However, after six years, two of which coincided with the NRPP study, we learned that tortoises exhibit extreme site fidelity, with 72% of tortoises not seen for one year or more ultimately being recaptured within 300 m of their original capture point, and 22% within 100 m of that point. The ease with which tortoises can escape observation is an important reason why we sought new methods.

At Joshua Tree we pioneered the use of distance sampling for tortoise surveys. In distance sampling, straight-line transects of precisely calculated length are surveyed by teams of observers. We measure the perpendicular distance to the transect line of any tortoises found. This method, championed by Dr. Ken Burnham and Dr. David Anderson of Colorado State University, has been successfully used on dozens of other animals including whales at sea, but only recently for tortoises. The method gives an accurate population estimate even if 70-80% of the animals present are missed.

During the present NRPP study, we abandoned all the plots except the Barrow site, using instead, these 4-km long distance sampling transects in the shape of a square to survey nearly the entire eastern half of the park. Most NRPP funds were expended on a work leader and a team of five Student Conservation Association (SCA) resource assistants each spring. The SCAs, in turn, supervised teams of two to eight volunteers recruited through newspaper and radio ads. These teams, usually two teams of 10 people each, walked the transects. In 1995, approximately 90 transects were surveyed and nearly as many in 1996. The only problem was that 1995 was a "good" year with plenty of rain, whereas 1996 was a drought year with less than 100 mm (3.9 in) of rain recorded at Twentynine Palms.

By using both plots and transects as corroborative methods, we gained many insights into tortoise surveying and monitoring. One of the most important findings was the significance of variability in rainfall and its effect on our ability to find tortoises. During years of high rainfall (and subsequent high forage production), tortoises will spend much of the spring above ground. During droughts, tortoises may remain underground to conserve water and energy. This can have a profound influence on the number of tortoises seen during the season. In 1995, a relatively wet year, our team walked 300 km (186 mi) of transects and found 203 tortoises. In 1996, an extremely dry year, we surveyed a similar number of transects and found only 30 tortoises with the same expenditure of effort. This discrepancy was also evident on the plots, and demonstrates the need to consider environmental parameters when conducting tortoise surveys, regardless of the survey method used.

Our findings indicate that a single year of surveys may yield questionable results, especially if weather conditions have been unfavorable for tortoises. Indeed, research suggests that surveys performed in drought years may not be valid. This problem could be overcome by developing a set of decision rules that would determine whether surveys should be conducted in any given year. For example, a certain minimum amount of rainfall or annual biomass production would need to be reached before a season is deemed acceptable for tortoise inventory and monitoring.

During the spring of 1997, Joshua Tree continued distance sampling, but also made a large effort to equip tortoises with radio transmitters in order to improve the sampling technique. Since tortoises often remain underground, depending on a variety of factors such as time of day, time of year, and temperature, many tortoises will not be observed during surveys. Radio-telemetry data can be used to estimate the proportion of tortoises underground at any given time; this information can then be used to adjust and improve future density estimates derived from distance sampling. This is the combination of methods presently recommended by the U.S. Fish and Wildlife Service for tortoise surveys.

Death Valley

Very little was known about the desert tortoise in Death Valley National Park, California, before the NRPP project. However, since 1994, 248 transects have been surveyed to determine the presence of the tortoise and to gather general density data. Tortoise sign was found along 60 transects, and sign counts indicate that population levels may be in the range of 20 to 50 animals per square mile in the Greenwater Valley area of the park. Elsewhere in the park, densities are much lower, and for the park as a whole, tortoise densities appear to be low when compared to other areas of the Mojave Desert.

The future

The work being conducted by the five parks is already contributing to the knowledge of the desert tortoise regionally. The methods pioneered at Joshua Tree, in conjunction with radio-transmitter studies, have been adopted by the U.S. Fish and Wildlife Service for tortoise sampling. At Lake Mead, we are continuing to expand our knowledge of the distribution of tortoises and their habitat using transect methods. Death Valley, Organ Pipe Cactus, and Saguaro will continue with survey and monitoring to develop a regional

Continued in column 3 on page 13

Springs and Seeps of Colonial National Historical Park

Groundwater study will help analyze off-site impacts to park ecosystem

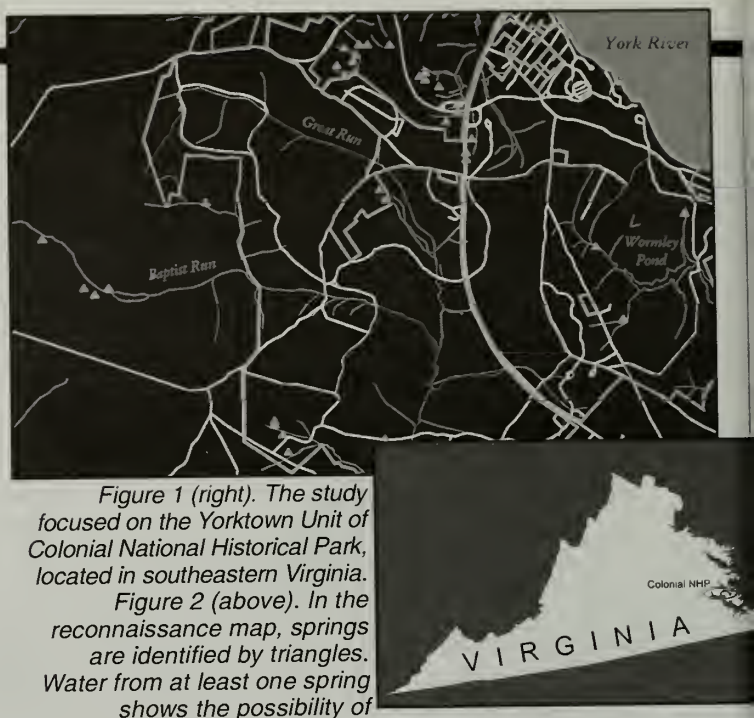

Figure 1 (right). The study focused on the Yorktown Unit of Colonial National Historical Park, located in southeastern Virginia. Figure 2 (above). In the reconnaissance map, springs are identified by triangles. Water from at least one spring shows the possibility of influences from deicing salts in runoff from a nearby roa

By Michael Focazio

The Yorktown unit of Colonial National Historical Park is located on the Atlantic coastal plain near the mouth of the York River in southeastern Virginia (fig. 1). In 1994, the park published a water resources management plan[1] that includes background information on the geology and water resources of the park. The plan states that contaminated or altered flow of groundwater could adversely affect the water resources and ecosystems of the park. For example, the Virginia Division of Natural Heritage has identified viable populations of northern spring isopods (tiny crustaceans listed as species of special concern in Virginia) that live in park springs[2]. The plan also indicates that little is known about the groundwater resources of the park and surrounding areas at the level of detail desirable for sound management activities. In 1995, the U.S. Geological Survey (USGS) submitted a proposal to the National Park Service entitled "Investigation of Shallow Ground-Water System at Colonial National Historical Park" outlining the work that would be necessary to achieve the desired level of understanding of the groundwater system. Currently underway is a study that was designed to address one aspect of that original USGS proposal while maintaining a phased approach to the overall investigation.

Study design important

This phase of the study was designed to provide some preliminary information that would be helpful in devising and implementing the overall investigation. Locations of springs in the Yorktown unit of the park and general indicators of water chemistry from the springs were deemed important initial information for the type of hydrogeologic environment found in the park. This preliminary information would be useful in future studies that assess relations of the water resources in the park to the nearby land uses that include residential areas, highways, forests, underground storage tanks, and National-Priorities List\Superfund sites. The information is also useful when assessing relations of water quality with occurrences and distributions of flora and fauna found in the park. Additionally, the knowledge gained from this study can be used for investigations of the surroundings and nearby natural resources such as the Grafton Pond Sinkhole complex. Forty sinkholes of the larger complex are found on park lands and contain hydrogeologic features and associated ecological systems that are unique to this part of Virginia.

Investigation begins

Investigators located 31 springs within the boundaries of Colonial National Historical Park during a field reconnaissance survey in May and August 1996. Outside the park boundary, we also located five additional springs that feed streams flowing to the park (fig. 2). The location of each spring was recorded with a Global Positioning System, and water from each spring was analyzed in May 1996 for pH (a measure of the acidity of the water), specific conductance (a measure of the amount of dissolved substances in the water, or salinity of the water), water temperature, and the amount of oxygen dissolved in the water.

The study focused on the Yorktown unit of the park, and not all streams that originate outside the park were searched for springs and seeps. We found the springs in various landscapes and elevations (fig. 3). Field observations indicate that water from most springs flows through a shallow aquifer system that is predominately comprised of fossil shell material (fig. 4). This shallow aquifer system is extensive and found throughout the park and surrounding land. Springs like these are not typically found in the coastal areas of Virginia and therefore provide unique ecological environments. The original source (recharge area) of the water issuing from these springs cannot be determined by these preliminary results. It is likely that the springs are recharged within the park boundaries and outlying areas. The water from at least one spring indicates that some springs are associated with a more local flow system that does not flow through the shelly aquifer and therefore have recharge areas that are restricted to within park boundaries. Water from another spring shows the possibility of influences from deicing salts in

[1]The report was prepared by Colonial National Historical Park, the NPS Water Resources Division, and the Center for Coastal Management and Policy, a contractor to the National Park Service under cooperative agreement # CA4000-1-0018.

[2]Springs and seeps are both manifestations of groundwater discharge but are defined differently. Seeps can be entire hillsides or other large plots of land where groundwater discharges to the land surface. Springs, on the other hand, are confined to limited areas, often found where small void spaces in the aquifer coincide with land surface.

Figure 3 (left). George Washington Spring, where the general's encampment got its water, is one of many springs surveyed during the study.

Figure 4 (above). Water from most springs flows through a shallow aquifer system that is predominately composed of fossil shell material.

Figure 5 (below). Different than springs, seeps can be entire hillsides or other large plots of land where groundwater discharges to the land surface. Springs are confined to limited areas, often where small void spaces in the aquifer coincide with land surface.

runoff from a nearby road. Additionally, water from all springs, where measurements were possible, was well oxygenated and had near neutral pH values.

We also found diffuse seeps of groundwater throughout the park (fig. 5). The seeps are located at, or near, headwaters of streams, along valley bottoms, and alongside streams. The locations of the seeps coincide with wetland maps that were previously generated for the park and are stored in the park's geographic information system.

Several springs that were flowing in May were dry in August. More work needs to be done to quantify why these springs dry up while others remain flowing; but it is likely related to topographic position and the aquifer material. The water from the springs was generally warmer, and had slightly lower dissolved oxygen in August than in May, indicating that the water is influenced by seasonal climatic changes. The pH and specific conductance were relatively unchanged between the May and August observations, suggesting that the overall chemistry of most springs did not change over the time period.

Water from eight selected springs was analyzed for chlorofluorocarbon compounds in order to determine modeled recharge dates. The dates from the five springs range from recent (within the past two years) recharge events to recharge that occurred in 1980.

Management of the biodiversity and ecological integrity of the park depends, in large part, on the quantity and quality of surface and groundwater flowing in, and through the park. This reconnaissance study indicates that groundwater that feeds streams within the park can be influenced by off-park and within-park activities. In order to effectively plan for the management of these resources, a more complete understanding of the shallow aquifer system within, and around, the park is needed. This would provide a framework from which relationships of the various local hydrologic environments to the presence and viability of specific targeted organisms (e.g., northern isopods) could be developed in context with potential influencing factors. PS

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Desert Tortoise continued from page 11

database. Continued research is of paramount importance for the future, and a reliable data set is needed to guide future research objectives. This will help us improve our ability to monitor populations of the desert tortoise and play a more effective role in securing its future. PS

Michael Boyles is a biologist with the USGS Biological Resources Division, Cooperative Park Studies Unit at the University of Nevada, Las Vegas. He has been working with the desert tortoise at Lake Mead since graduating from UNLV in 1994 with a master's degree in biology. He can be reached at (702) 293-8978 or michael_j._boyles@nps.gov. *Dr. Jerry Freilich is former Ecologist at Joshua Tree National Park. He is now Director of Conservation Science for The Nature Conservancy in Lander, Wyoming, and can be reached at (307) 332-2971 or* jfreilich@rmisp.com.

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Redwood National and State Parks, Howard F. Sakai

Figure 1. Wilson's Warbler is one of the common neotropical migrant bird species caught in mist-nets during the breeding season from 1993 through 1997 in an alder-dominated riparian habitat in Redwood National and State Parks

Redwood National and State Parks' Neotropical Migratory Songbird Program:

Monitoring for Avian Productivity and Survivorship (MAPS)

By Howard F. Sakai

Redwood National and State Parks, a world heritage site and biosphere reserve, are recognized for their magnificent groves of relict old-growth coastal redwoods *(Sequoia sempervirens)*. Concomitant with old-growth redwoods, the California parks' 42,719 hectares (approx. 106,000 acres) contain a mosaic of habitat types including coastal dunes/scrub/mixed-conifer forest, second-growth redwood/mixed conifers, riparian red alder-dominated *(Alnus rubra)* corridors, Douglas fir/mixed conifer/hardwood, coastal grasslands, and oak-woodlands. A diverse bird species richness of 404 species, as noted in the parks' bird checklist, illustrates the influence of this diverse mix of habitats. Neotropical migrants, defined as species for which the majority of the population winters south of the U.S.-Mexico border, make up about 27% of the total species occurring within the parks. Only recently has the demise of migratory songbirds on their breeding and wintering grounds been given national and international recognition. This threat has been acknowledged through ongoing research and monitoring efforts by public, private, and philanthropic agencies involving international cooperation. For this article, I will describe an ongoing monitoring program Redwood is conducting on neotropical migratory songbirds, discuss some of the study results, and briefly provide an assessment of the program.

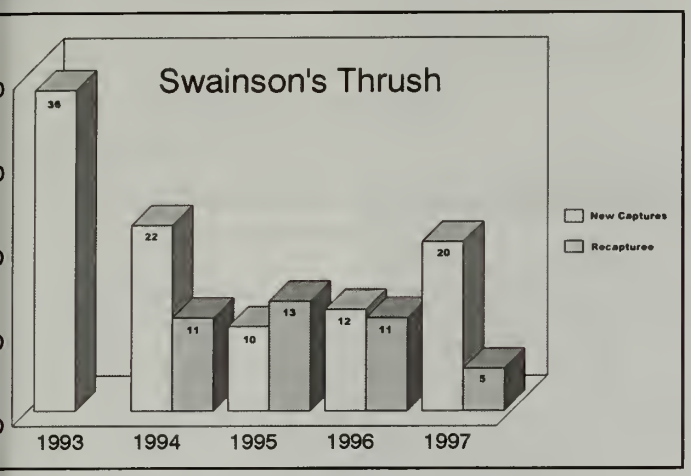
MAPS

Our constant-effort mist netting study (Monitoring for Avian Productivity and Survivorship or MAPS), initiated in the summer of 1993, provides baseline information and is one of several ongoing park bird projects contributing to the understanding of neotropical migratory songbirds on their breeding grounds. Our MAPS program provides critical long-term data to a broader regional study conducted by Dr. David DeSante of the Institute for Bird Populations at Point Reyes Station, California. Dr. DeSante's study is attempting to compare the productivity and survival of migratory songbird species throughout their breeding range.

The park MAPS study area is located within a 6-ha (14.8-acre) riparian corridor dominated by mature red alder. Our constant-effort mist-netting station followed Dr. DeSante's MAPS protocol for maintaining standardization amongst all participating MAPS cooperators. Ten mist-nets spaced 150-200 m apart within the study area were operated for six hours per day, starting within 15 minutes of sunrise, every 10 days between mid-May and mid-August. All captured birds, except hummingbirds, game birds, and raptors, were marked with a U.S. Fish and Wildlife Service sequentially numbered aluminum leg band. All newly captured birds were processed for a variety of morphological and physiological measurements. Recaptured birds were also processed again and identified by their band numbers.

Costs and other considerations

The cost of operating a MAPS station is dependent upon initial equipment investment (in 1993 about $750, which included 24 electrical conduit poles and rib bars, 15 mist-nets, and 100 feet of 1/8" nylon rope); replacement mist-nets every second or third year (five nets at current price of $250); personnel costs, which vary with type of personnel (volunteer or paid staff) and grade level for 80 hours per sala-



ure 2. Captures and aptures of Swainson's Thrush, 93-'97

ried individual per breeding season; and number of personnel needed to operate a MAPS station (dependent upon participant level of expertise). Safety of netted birds should always be the primary concern for any program manager operating a mist-netting station. Accordingly, two trained bird banders are highly recommended in operating a MAPS station; however, an experienced bird bander with several years of experience could independently operate a station while still maintaining bird safety. At our parks, an experienced bird bander with a *master* bird banding permit supervised either one or two inexperienced staff members the first three field seasons for the purpose of providing training. For the 1996 field season, the experienced bird bander ran the MAPS station alone for an extended period, which contributed to lower program cost. However, a program manager should never use less staff to simply lower operation cost without *always* first considering the safety of netted birds.

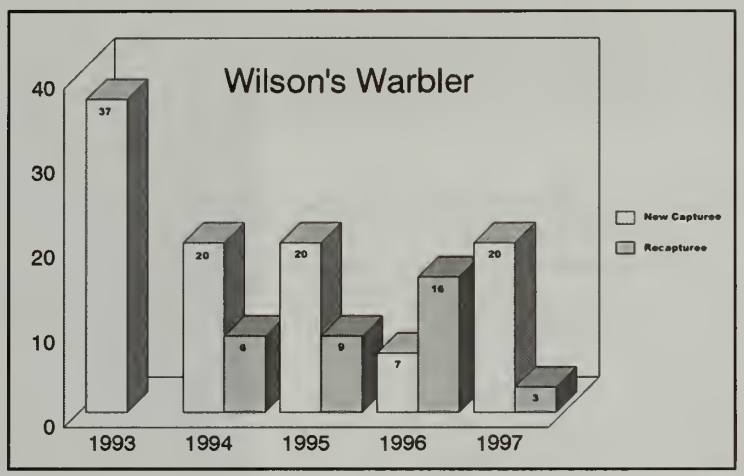


Figure 3. Captures and recaptures of Wilson's Warbler, 1993-'97

Results and discussion

Results of our four-year mist-netting effort during the breeding season provided baseline information for 15 migrant and resident species. The most commonly caught migrants were Swainson's Thrush *(Catharus ustulatus)*, Wilson's Warbler *(Wilsonia pusilla* [fig. 1]), and Pacific-slope Flycatcher *(Empidonax difficilis)*. Winter Wren *(Troglodytes troglodytes)* and Varied Thrush *(Ixoreus naevius)* were the most common resident species. The constant-effort mist-netting technique provides a means for monitoring species movement within the study area, especially for lower to mid-canopy species, and verifies for the uncommon species their presence or rarity. For example, an unexpected mist-net capture in July 1996 of an Ovenbird *(Seiurus aurocapillus)*, a species common to the east coast and ranging as far west as Colorado, documents its presence within the parks despite being outside of its normal range. A similar unexpected capture of a Brown-headed Cowbird *(Molothrus ater)* in our forested riparian study area documents its rare presence, as this species is normally not common in interior forested habitat. However, the Brown-headed Cowbird does occur locally in agricultural fields about 1½ miles from our study area. This capture could be a precursor to the cowbird's potential threat to this interior riparian habitat.

Recovery of marked individuals from previous banding efforts documented site fidelity for the common migrant and resident species. Yearly recaptures of migrant Swainson's Thrush (fig. 2) and Wilson's Warbler (fig. 3) individuals have been documented since the inception of the banding program in 1993. Recaptures of migrant Pacific-slope Flycatcher (fig. 4) individuals were documented for one summer. Of the common migrant individuals recaptured for two or more consecutive summers, the male to female Swainson's Thrush (n=20) and Wilson's Warbler (n=19) recapture ratio was 70%:30% and 68%:32%, respectively. A similar comparison for Pacific-slope Flycatcher recaptures by sex was impossible as males and females could not be distinguished by plumage or anatomical (i.e., cloacal protuberance) differences, and none of the captured individuals possessed a brood patch. Analysis by mist-net capture locations showed that 15 of the 20 returning Swainson's Thrushes, 11 of the 18 Wilson's Warblers, and 1 of 2 Pacific-slope Flycatchers were caught within a 300-m or less radius of their initial capture location. It is simply amazing that these tiny migrant songbirds survive the perils of migration, over several consecutive years, to return to the same breeding location from

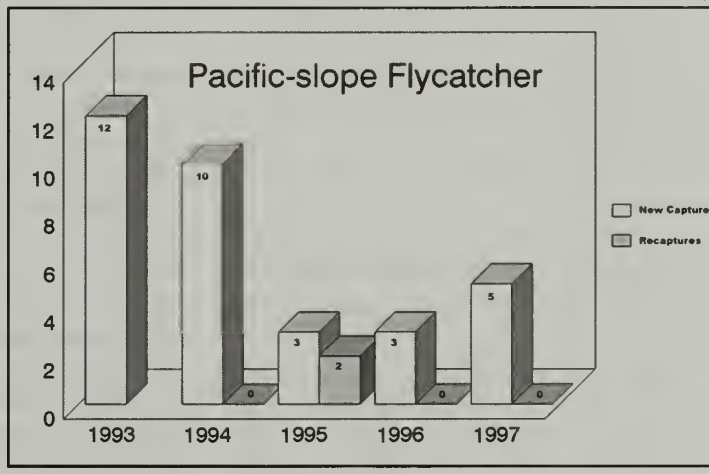


Figure 4. Captures and recaptures of Pacific-slope Flycatcher, 1993-'97

Continued in column 3 on page 19

Survey and Monitoring of Birds on the Timucuan Preserve

Timucuan Preserve, Daniel R. Tardona

Figure 1 (left). The Timucuan Preserve features diverse habitats that include marshes and upland areas, which are important for birds.

Figure 2 (below). The Wood Stork is an endangered species that nests within the preserve.

By Daniel R. Tardona, Roger Clark, Amy E. Hanigan, and Ian Hanigan

Named for the Native Americans who lived here for more than 3,000 years, the Timucuan Ecological and Historic Preserve on the Atlantic coast in northeast Florida encompasses hammock uplands, coastal marshes (fig.1), salt flats, islands, tidal creeks, and the estuaries of the St. Johns River on its southern perimeter and of the Nassau River on its northern perimeter. Almost 75% of the lands in the preserve are wetlands and waterways. The preserve teems with a wide variety of plant and animal species.

The preserve is especially important for birds (fig.1). It is the lower breeding limit of many northeastern bird species; it is in the Atlantic flyway and offers habitats for wintering and migrating birds; it provides habitats for birds that depend on estuarine and maritime environments; and it is a refuge for many birds that are increasingly threatened by land development and recreation along coastal areas (fig. 2).

Sound management of bird habitats in the preserve and region requires knowledge about population sizes, seasonal and annual species compositions, and the relative abundance of species across specific sites. The preserve began collecting such data in 1996 with plans to maintain these efforts as a permanent avian monitoring program. Survey results are recorded in an automated management database, provided by the U.S. Fish and Wildlife Service, which provides resource managers with a tool to track population trends and evaluate avian responses to specific management actions to various habitats.

Study sites

Two sites in the preserve were selected for the collection of data. The 159-ha (392 acre) Cedar Point area consists of tidal marshes, upland oak (*Quercus spp.*) forests, hammocks, pine (*Pinus spp.*) flatwoods, and a remnant pine plantation. The upland areas are interspersed with small freshwater wetlands (fig. 1). The approximately 243-ha (600-acre) Theodore Roosevelt area consists of tidal marshes, brackish sloughs, and a relatively undisturbed maritime hammock community. A recently acquired third site, the 474-ha (924-acre) Thomas Creek area, will be added in the spring of 1998. The mixed-forest wetland at Thomas Creek includes a 106-ha (262-acre) hardwood freshwater wetland, an 11-ha (27-acre) lake (borrow pit), and important upland areas. The north end of the area is bordered by saltmarsh and has been managed as a pine plantation of mostly loblolly pine (*Pinus tadea*). This area will be important to survey and monitor for birds as it will be transformed to a more natural vegetative state beginning in approximately six years.

Methods

Because the small staff compliment of the preserve was not available for the survey and monitoring of birds, we placed a call for volunteers in the *Opportunities for Birders*, an annual publication of the American Birding Association, and was promptly met with numerous responses from experienced birders. The local chapter of the Audubon Society and area ornithology students also augmented our volunteer roles to expand and maintain the program.

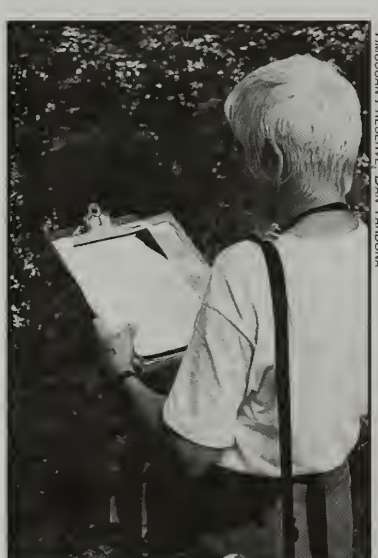
The number of birds by species in the study sites is estimated with point counts (Hamel et al. 1995; Ralph et al. 1993). A point count is a tally of all birds detected by sight or sound by a single observer from a fixed station during a specified time period. The survey points are distributed as evenly as possible throughout each of the two study areas at a minimum separation of 250 m (820 ft.). The points were established by overlaying a 250-m x 250-m scaled grid on detailed maps of each study area. Intersections of trails in the preserve and accessible areas at grid nodes

were potential sampling points. The maximum number of intersections in each site were generated by moving the grid. One of the intersections was chosen as a starting point from the grid. By drawing a 250-m circle around a random point, the next point was located at a trail intersection or at an accessible area on a grid node and the circle. In the field, each sampling point was marked with a stake (fig. 3) and a map of the points was given to each observer.

TIMUCUAN PRESERVE, JAYNE TARDONA

Figure 3. The first author stakes one of the bird survey points

During a point count, each observer (one or two) makes a series of 10-minute observations beginning 30 minutes before dawn until 10:00 a.m. The observation periods are separated into segments of the first three minutes, the next two minutes, and the final five minutes, for a total of 10 minutes of observation per location. The distance between the observer and birds is recorded in one of four categories: less than 25 m distant, 25-50 m distant, over 50 m distant, and flyovers. Data are recorded using a bull's-eye data record sheet (fig. 4) for each count station. The observer orients the sheet, records date, time, observer, and wind and sky conditions, and then begins the count using a timer. Each bird that is seen or heard is recorded, noting distance and approximate azimuth (i.e., compass bearing). A multicolored pen is used to record data for the different time intervals: green for the first three minutes, blue for the next two, and red for the final five. Each bird observed or heard is recorded just once with a mark (using a species code); thus, observers must judge whether subsequent songs are from new or already mapped individuals. All flyovers are recorded outside of the bull's-eye underneath *flyovers.* The field notations from the bull's eye data sheets are transcribed to bird count data forms at the end of the day, and the data are then entered into the U.S. Fish and Wildlife Service GSB-Base Bird Monitoring Database. One survey is made at each site during the spring migration, fall migration, breeding season, and during the winter.



TIMUCUAN PRESERVE, DAN TARDONA

Figure 4. Park VIP Carol Richards collected survey data in the field using the bull's-eye data record sheet. Data from each observation point were later consolidated on another form and entered into a database for analysis.

Results and discussion

Preliminary data collected suggest that the Timucuan Preserve study areas contain one of the highest concentrations of nesting Painted Buntings *(Passerina ciris)* in northeast Florida. This species is of particular concern in the region as a result of habitat loss. In addition, the data suggest that compared with other point counts in the southeast our study areas have a lower concentration of the Brown-headed Cowbird *(Molothrus ater).* The cowbird is a brood parasite that lays its eggs in the nests of other bird species. Its eggs hatch earlier than those of its host, and the chicks grow faster, reducing the food intake of the host species. As a result, the cowbird threatens the survival of many other bird species especially warblers, flycatchers, vireos, and finches. Further data collection and analysis over the years in conjunction with other habitat studies will yield important information to consider in future habitat management decisions.

Conclusion

In order to achieve many important resource management objectives within funding and staffing limits, resource managers must continually seek creative and nontraditional alternatives. As we have shown with the Timucuan bird survey, important and viable natural resource management programs can be accomplished with the assistance of knowledgeable, skilled, and dedicated volunteers. In addition to the benefit gained from the data gathered during the surveys, involvement of people from the local community can also strengthen and expand support for park goals and management activities. PS

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Daniel Tardona is West District Supervisor at Timucuan Ecological and Historic Preserve, Florida; he holds a M.A. in experimental psychology and has research interests in animal behavior and natural resource management. Roger Clark is a Park Ranger at the preserve and has a B.S. in natural history with research interests in bird study. Amy Hanigan is a NPS Volunteer in the Parks (VIP) and American Birding Association (ABA) volunteer. She is an attorney with interests in birding and nature study. Ian Hanigan is a VIP and ABA volunteer. He is a financial advisor with birding and nature study interests. All authors can be reached at (904) 641-7155 and cc:Mail–FOCA Rangers.

Pacific Meridian Resources

Figures 1 (left) and 2 (right). The database development process uses Thematic Mapper satellite images, such as these of Olympic (left) and Mount Rainier (right) National Parks, Washington. The images reveal tree size and forest structure, species composition, forest crown cover, and geomorphic characteristics of the land. Clear cuts outside the parks show as white patches.

Vegetation and Landform Database Development

Satellite imagery eases updates, applicability in Pacific Northwest parks

By Jeff Campbell and David Peterson

An important new database was recently developed for national parks in the Pacific Northwest that will aid resource managers and scientists interested in a wide variety of natural resource issues. In 1992, the Natural Resource Preservation Program of the National Park Service provided funding for a contract with Pacific Meridian Resources, Portland, Oregon, to develop and produce a comprehensive GIS vegetation land cover and geomorphologic landform database for four national parks in the Columbia-Cascades Cluster: Olympic, North Cascades, and Mount Rainier National Parks, Washington, and Crater Lake National Park, Oregon. The study was designed to develop a comprehensive, consistent inventory and mapping of the vegetation and landform characteristics for the four parks using digital Landsat Thematic Mapper (TM) satellite imagery (figures 1 and 2) and field collected data as the primary information bases.

Using satellite imagery as the primary information base for developing a comprehensive, consistent vegetation landcover database has four advantages:

1. Substantially less time and cost is needed to produce the GIS layers as compared to aerial photo interpretation
2. Much more useful data can be produced; image raster data can be intersected with GIS polygon (vector) coverages providing information about the diversity of vegetation cover within each polygon
3. Analyses across ownership boundaries can be performed. The great economies of scale provided by digital image processing make it relatively inexpensive to map large expanses of land
4. Landsat TM satellite data are captured over the same area every 16 days. Thus, fast and inexpensive database updating is possible. Landsat TM data and extensive field-based observations were used as base data for the study. Computer classification was an iterative process. Aerial photographs, ancillary GIS layers, field and office reviews, and NPS personnel input were used to refine the maps through modeling and manual editing

Products

Final products resulting from the study are three separate raster GIS data layers of tree size and forest structure, forest species, and forest crown cover. Image-based raster map acreage totals for these layers are included in the final report for the project. In addition, a spatially related database of vegetation characteristics was developed from the compilation and analysis of an extensive vegetation inventory completed for each park as part of this study. Also, a digital map of geomorphologic landforms was produced through the analysis and interpretation of digital elevation data, aerial photography, and digital satellite imagery.

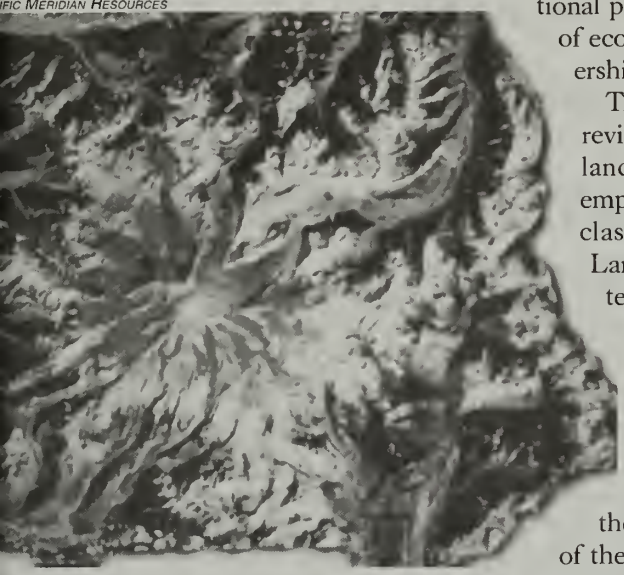
The accuracy of the image classifications was assessed and difference matrices are provided for the study. Accuracies in excess of 85% were achieved for all image-based data layers. More extensive field data collection, draft map review, and editing would further improve the quality and accuracy of the map data. The map data should be viewed as a dynamic, evolving database that should be consistently updated, evaluated, and improved.

Databases improved

The powerful, comprehensive databases developed through this study have several distinguishing characteristics: these databases provide the National Park Service with comprehensive baseline data

for each park in the Pacific Northwest. This data set can serve the basis for various long-term ecological research and monitoring efforts. The hierarchical data structures for the databases allow for landscape characterization and analysis at multiple scales. Future studies and analy-

IFIC MERIDIAN RESOURCES



ses can utilize these data sets for project- or watershed-specific areas or for more broad-based, regional and landscape-scale analysis by utilizing the full detail of the data or by aggregating the data into broader categories of information.

The raster data sets provide a more realistic depiction of diversity and variation of landcover across the landscape than do polygonal, usually photo-interpreted, data sets providing a single landcover label for often large (several acres) land areas that many times possess tremendous biodiversity.

Data uses expanded

The integration of spatial and tabular data provide greatly expanded applications for both data sets. Field-based measurements not measurable from remotely sensed data can provide much greater site-specific descriptions of cover types produced from satellite imagery. The spatial cover type data provide the means to consistently stratify field-based measurements and apply them across a park. The result is a powerful data set that can be used not only for general, regional summary statistical measurements, but also for site specific spatial assessments (i.e., habitat conditions, connectivity, biological indicators, etc.)

The data classification schemes allow for seamless analysis of ecosystems across the landscape regardless of ownership. Obviously, since the ecological world does not end at the boundaries of national parks, comparison and analysis of ecosystems across adjacent ownerships is critical.

The databases are easily updated, revised, and enhanced. Since the landcover classification process employed easily repeatable image classification methods utilizing Landsat TM imagery, change detection analysis and map updating procedures can result in a very cost-effective and fast approach for keeping the data sets current. Also, the standardized field data collection procedures allow for the enhancement and expansion of the field-based vegetation inventory database during future field studies.

Finally, as accurate, comprehensive, and powerful as the databases developed from this study are, they will only gain true legitimacy and the confidence of the user through extensive use and review. The potential utility and application of the data sets is limited only by the imagination of the user. While these databases certainly do not represent the end-all data sets needed for the region, they do provide a powerful state-of-the-art launching pad for further study, analysis, and ecosystem management for the parks of the Pacific Northwest. PS

Jeff Campbell was with Pacific Meridian Resources in Portland, Oregon, at the time of the study. David L. Peterson is the Unit Leader of the Cooperative Park Studies Unit, Forest and Rangeland Ecosystem Science Center, USGS-Biological Resources Division, Seattle, Washington. He can be reached at (206) 543-1587; Fax (206) 685-0790; e-mail wild@u.washington.edu.

Redwood continued from page 15

their wintering grounds located many thousands of miles away (i.e., Mexico, Belize, and Guatemala for Wilson's Warbler and Pacific-slope Flycatcher; northern South America for Swainson's Thrush)!

Conclusion

The Redwood MAPS station validates the importance of this riparian corridor for these three neotropical migrants. However, more constant-effort mist-netting stations are needed to verify our results for similar riparian habitats throughout the park complex or within the species' breeding range. Although our findings are limited to our study area, our parks' contribution of data to the Institute for Bird Populations is very useful for the regionwide analysis in comparing productivity and survivorship of these species within a portion of their breeding range.

There are obvious beneficial uses of MAPS data, but there are limitations, as well. For example, inferences may be made for a banding site only and may not be extrapolated to broader areas. Regardless of this limitation, the low overhead cost for materials ($750) invested in establishing the MAPS station is worth the expense. Such easily and inexpensively collected data also clearly illustrate the importance of each habitat in a broader ecosystem context. Redwood can monitor a vital sign related to its resources that is pertinent on a local and regional scale. Because of the stability of parks, these protected areas are particularly critical for the survival and maintenance of these long-distance migrants. Parks have a responsibility to participate as much as possible in this way given the broad context of ecosystem management and maintenance of biodiversity. PS

Howard F. Sakai is Supervisory Ecologist, Resource Management and Science Division, at Redwood National and State Parks, California. His phone number is (707) 464-6101, extension 5270 and his e-mail address is howard_sakai@nps.gov.

Meetings of Interest

1998
May 5-7

Researchers and partners in land stewardship may be interested in "A Century of Parks in Southern Arizona: The Second Conference on Research and Resource Management in Southern Arizona National Park Areas." The three-day conference will explore the areas of archeology, historic preservation, ecosystems, physical sciences, and both plant and wildlife ecology and management. A closing session will address publicizing research results. Contact Kathy Hiett of the USGS Cooperative Park Studies Unit at the University of Arizona in Tucson for registration information: (520) 670-6896, ext. 3; *katherine_hiett@nps.gov.*

May 27-31

The University of Missouri is sponsoring the Seventh International Symposium: "Society and Resource Management" to be held on the Columbia, Missouri, campus. The biennial symposium focuses on the contributions of the social sciences and humanities to a better understanding of the environment and resource management. The goal is to foster increased dialogue among natural resource managers, social scientists, policy makers, and researchers. A commitment to understanding the links between culture, environment, and society will be the guiding theme at the 1998 event. This thrust is based on the notion that complex resource issues are societal problems grounded in cultural systems and can be addressed by multidisciplinary perspectives. Presentations will explore natural resources and local communities, cultural diversity and gender issues in natural resource management, the social and cultural dimensions of environmental conflicts, social science perspectives on land-use issues, international issues in resource management, biodiversity management, and public participation in natural resource planning, among others. For more information, visit the website *http://www.ssu.missouri.edu/SSU/issrm/default.htm* or contact Sandy Rikoon at (573) 882-0861; *ssrsjsr@muccmail.missouri.edu.*

October 13-16

Still a year away, the Seventh Annual Watchable Wildlife Conference is now accepting proposals for papers. The conference promises to explore innovative ways to appreciate wildlife, and will bring together people from government agencies, nonprofit organizations, and the business community. Conference tracks include conservation education, recreation and tourism, expanding the Watchable Wildlife program, and others. Visit the Watchable Wildlife website *http://sturgeon.irm1.r2.fws.gov/u2/refuges/watchwil/main.html* or contact Jill Simmons at (505) 248-6635; *jill_simmons@mail.fws.gov.*

May 23-27, 1999

Dates have changed for the conference, "Wilderness Science in a Time of Change," to be held in Missoula, Montana. Originally scheduled for May17-22, 1999, the meeting will now take place May 23-27. A description of the conference appeared in *Park Science* 17(1):16. For additional information, contact the Center for Continuing Education at (406) 243-4623; *ckelly@selway.umt.edu.*

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PARK SCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT
Volume 18 • Number 1 • July 1998
National Park Service • U.S. Department of the Interior

Social science in the national park system:
An assessment of visitor information

By Robert E. Manning and Benjamin Wang

IT IS BECOMING A TRUISM THAT MANAGING national parks means managing people (fig. 1). The national park system will accommodate nearly 300 million visits annually by the turn of the century. Growing numbers of visitors present challenges to the National Park Service to meet its mission of protecting park resources and providing for public enjoyment.

People play an important role in this mission. Visitors are a primary cause of impacts to park resources, and research suggests that such impacts are a function of visitor behavior (activities, spatial and temporal use patterns) in addition to resource characteristics (Hammitt and Cole 1987). Moreover, public enjoyment of the national parks must be defined through understanding of the visitor experience, which research suggests may sometimes be at odds with the perceptions of park managers (Manning 1986). This issue is further complicated by the diversity of sites within the national park system and the concomitant diversity of visitors. And visitors are only one of the publics of concern to national park managers: others include employees, residents of local communities, concessioners, interest groups, and, ultimately, society at large.

Important management tool

The relationship between people and parks suggests the importance of social science. Within the National Park Service, social science has recently been defined as "the disciplines of science that study humankind in relation to its cultural, social, and physical environment" (Machlis 1996). Social science is one of the three main divisions of human knowledge (along with natural sciences and the humanities) as traditionally defined by academic institutions. Social science typically includes the disciplines of anthropology, archaeology, economics, geography, human psychology, political science, and sociology. All of these disciplines can contribute to our knowledge and understanding of visitors to the national park system.

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Figure 1. Backpacking, sight-seeing, enjoying wildlife....The pursuits of visitors to national parks are numerous and diverse. Yet, scientific information about the behavior of visitors and their park experience (motivations, level of satisfaction, and attitudes) is not commonly available to park managers according to the recent study. With a mission to protect park resources and provide for public enjoyment, the National Park Service needs consistent visitor information in order to manage parks and people as effectively as possible.

Given the general importance of social science and the particular importance of information on visitors, to what extent is such information available to park managers? What types of information are available? What are the primary sources of this information? A recent study provided insight into these and related questions.

In 1996, the National Park Service was authorized by the Congress to design and implement an experimental user fee system, now commonly known as the Recreation Fee Demonstration Program. This legislation requires the National Park Service to monitor and evaluate the effects of this new fee system. This information will be used by the Congress to help determine if this new fee system will be continued on a permanent basis.

Continued on page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 18 – No. 1 · July 1998

Published by
The National Park Service
U.S. Department of the Interior

Director
Robert Stanton

Associate Director, Natural Resource Stewardship & Science
Michael Soukup

Editor
Jeff Selleck

Park Science (ISSN-0735-9462) is a science and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations—materials do not undergo refereed peer review. *Park Science* is also available online (ISSN-1090-9966) at *www.nature.nps.gov/nrid/parksci*.

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Please refer to guidelines published in volume **16(3):**5-6 and online, or contact the editor:

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Printed on recycled paper

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In the next issue...

Graduate student Paul Lachapelle describes an experiment to test solar energy as a way to treat human waste from backcountry composting toilets. Also look for reports on tumors in gizzard shad at Chickasaw National Recreation Area (Oklahoma), a real-time air quality data display at Great Smoky Mountains National Park (Tennessee and North Carolina), and exploring the carrying capacity issue on the carriage roads of Acadia National Park (Maine).

The human dimension

Social science studies are the focus of two articles in this issue. An important management tool, social science can provide answers not only to questions about the basic kinds of activities that visitors engage in, but also about their motivations, level of satisfaction, and attitudes related to their park experience. However, as our cover story indicates, this information is not commonly available to park managers. Clearly, we need to be asking more of these kinds of questions, which is what Rocky Mountain National Park and the U.S. Geological Survey have done in their study on the attitudes of backpackers and day users in the park, our second social science report. Both stories are reminders that park management is as much about managing people as it is about managing natural and cultural resources.

Another facet of the human dimension in park management is the quality of leadership within our own ranks. In an interview, our first, Lake Mead National Recreation Area Superintendent Alan O'Neill discusses his success in building a top resource management program at the park during the last decade. His talents as a manager are inspirational and his methods for redirecting a park's energies toward resource preservation and gaining support for increased resource management program funding are insightful.

Jeff

Editorial board openings

Park Science needs to fill several vacancies on its editorial board. The superintendent slot, formerly occupied by Wrangell-St. Elias Superintendent Jonathan Jarvis, is now open. (Thanks, Jon, for your keen insights and experienced views). Also, the editorial board has decided to add two new positions to its ranks to help round out the expertise available to the editor. The new slots are for a social scientist and a natural resource interpreter. Terms are six years in length except for the superintendent term, which is three years. Terms are staggered to offer continuity. To fit in with the current staggered rotation, the superintendent will serve for three years, the social scientist six years, and the interpreter four years. New terms begin in January 1999.

Responsibilities

With a purpose of furthering the application of research in park management, *Park Science* relies on the expertise of its editorial board members to provide guidance on the technical content and general management of the publication. The primary responsibility of board members is to review articles submitted for publication and provide feedback on the general soundness of the research methods and findings. They also evaluate the implications of the research for park planning and management, ensuring the relevance of articles. Board members suggest topics for articles and thematic issues, contribute materials, and help funnel Highlights and other appropriate stories to the editor. They are also available for consultation in matters related to the routine management of the publication (e.g., planning, circulation, funding). Time commitment varies, but usually does not exceed 16-24 hours per year. Board meetings are usually conducted annually by phone and every other year at a gathering convenient to all (e.g., the George Wright Society conference). Routine business is conducted by e-mail and phone.

Eligibility

The superintendent who will serve on this editorial board must have a good understanding of the role of science in park management. The social scientist must be able to relate social science research to managing people and parks. The resource interpreter must be familiar with environmental education and outreach techniques to help improve the educational value of the information presented.

Nominations

Nominations for the superintendent, social scientist, and resource interpreter board positions are now being accepted by the *Park Science* editorial board chair. Please submit a brief (one to two paragraph) statement on your interest in serving on the editorial board, for which slot, and the skills you offer the group. Nominations are due August 15. Please forward them to Ron Hiebert; Associate Regional Director for Natural Resources; Midwest Region; 1709 Jackson Street; Omaha, Nebraska 68102; 402-221-4856; e-mail: *ron_hiebert@nps.gov.*

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Year-in-Review articles needed

The second annual *Natural Resource Year in Review* was recently circulated to parks, partners, environmental organization, and academic institutions. A comprehensive summary of the year's most significant trends and issues, the *Year in Review* is intended to increase interest in, understanding of, and support for natural resource management in the national park system. Although 1998 is only a little more than half way past, it is time to begin planning the next edition!

The 1998 calendar year report will present a balanced selection of the year's major issues and trends, sharing both national and park stories. Our task is to select the most compelling stories that help us explain our role and responsibility in preserving park natural resources. Most important is the analysis of issues and trends, explaining what they mean for natural resource management in the National Park Service.

Organization

Organization of the report will grow out of the materials submitted; however, the following categories may help potential authors envision the kinds of stories being sought:

1. Threats (the complexity and diversity of threats to natural resources);
2. Meeting Demands (initiatives and staffing and funding issues);
3. Resource Knowledge (gathering information on resources and their condition);
4. Planning and Preservation (the role of planning in natural resource preservation)
5. Working Together (the indispensable nature of partnerships);
6. Restoration (ecological restoration);
7. Legislation, Policy, and Legal Challenges;
8. New Horizons (the demand for innovation in attacking problems);
9. People and Preservation (the vital role of a professional staff in resource preservation);
10. Dealing with Dilemmas (controversial or complex natural resource management problems and evolving solutions).

Call for article proposals

The editor is now soliciting article proposals for the 1998 *Year in Review* and would like to encourage broad participation. Please review the major trends and resource issues your park and the agency faced during 1998 as potential stories for the report. If you would like to propose an article, please provide a one-paragraph (50-100 word) synopsis of the story. Clearly relate the proposed story to calendar year 1998. Identify trends and analyze how the issue demonstrates local, regional, or national significance. What typified 1998? Where did the NPS gain or lose ground? Give a larger meaning to the story if possible.

Deadline

Please submit proposals by e-mail to *Park Science* editor *jeff_selleck@nps.gov* by August 30. If your proposal is selected, you will be contacted to develop the story into a feature (~450 words) for an October 30 deadline. Proposals not selected for articles may be used as factoids or as Highlights in *Park Science.* PS

ALASKA

Harbor seal decline studied in Kenai Fjords

Marine wildlife including harbor seals *(Phoca vitulina)* are major visitor attractions in the productive, deep-water fjords adjacent to Kenai Fjords National Park (Alaska). Numerous tour boats bring hundreds of visitors to these waters daily to view seals hauled out on ice calved from tidewater glaciers. However, disturbing declines in harbor seal populations prompted park resource staff to study impacts to the population. In 1980, more than 1,600 seals were counted at the head of Aialik Bay, yet fewer than 300 seals have been counted annually in the same waters since 1989. One ongoing study documents the relationship between an approaching vessel and a seal's behavior to avoid the disturbance. Results may aid the park in developing and recommending guidelines for vessels approaching seals.

This issue is further complicated by park legislation mandating that the Park Service actively protect seals and haulouts in marine waters outside the park. To comply with the mandate, the park initiated a cooperative, multiagency study in 1997 to identify factors contributing to the continuing population decline. Park resource managers and biologists from the National Marine Mammal Laboratory (Seattle, Washington) collaborated for the first-ever live-capture of harbor seals that use floating glacier ice as a primary haulout. The multiagency team includes biologists from the Alaska Department of Fish and Game, University of Alaska–Fairbanks Institute of Marine Science, and a visiting Russian scientist. The team used a floating "gill net" to capture the seals. After each seal was safely lifted onboard the boat, its condition was determined and vital statistics, including sex and weight, were recorded. Blood and tissue samples were obtained from each animal and a small radio transmitter was attached to its rear flipper. The radio transmitter will provide critical information on harbor seal migration, habitat use, and haulout patterns. The new capture method is being used again this year by park staff and National Marine Fisheries Service researchers. The research team is working to develop an understanding of harbor seal population dynamics, declines, and effects of human-induced disturbance in waters adjacent to the park.

SOUTHWEST

Low lake levels spawn archeological discoveries at Amistad

Following five years of regional drought in southwest Texas and northern Mexico, lake levels at Amistad National Recreation Area plunged to historic lows–more than 55 feet below normal levels. Archeological surveys conducted by park archeologist Joe Labadie and six SCA/AmeriCorps members in draw-down areas have identified over 110 previously undocumented archeological sites that date from about 6,000 B.C. to about A.D. 1500.

Most sites consist of fire-cracked rock features and range in size from several small hearths to sites that cover more than 5 acres with more than 140 hearths and burned-rock middens. Initial studies have demonstrated that, in many cases, archeological deposits within previously inundated fire-cracked rock features have been replaced by modern lake deposits associated with wave action even though the features look (morphologically) to be intact.

The initial hypothesis is that an optimum ground slope seems to exist where wave-action effects are negligible; above or below this angle wave action is intensified, producing predictable dispersal patterns across the site. Typically, archeological sites with ground slope angles above 10 degrees will have a series of individual cut-banks often resembling stair-steps. Sites with low ground-slope angles (>3 degrees) will exhibit a parallel series of drift lines (similar to high tide lines at an ocean beach) consisting of chert flakes, artifacts, and small fraction fire-cracked rocks. In such settings, horizontal relationships among artifacts or feature-specific lithic associations are tenuous given the number of times most archeological sites have been subjected to the repeated cycle of inundation, exposure, and reinundation.

• • •

Rare pronghorn behavior photographed at Organ Pipe

Resource Managers at Organ Pipe Cactus National Monument (Arizona) recently documented the use of open-water pools by the endangered Sonoran pronghorn *(Antilocapra americana sonoriense)*. As part of an NRPP (Natural Resources Preservation Program) project, resource managers placed infrared-triggered Trailmaster camera systems at selected water sources and travel corridors in the park to determine use of these features by pronghorn.

Use of freestanding water by the Sonoran pronghorn is the subject of continuing scientific and management debate. Before this project, the only confirmed use of freestanding water by the subspecies was from a photograph of a pronghorn drinking at a muddy bomb crater on the Barry M. Goldwater Bombing Range, northwest of the monument. Last summer, Organ Pipe Wildlife Biologist Tim Tibbitts and Biological Technician Lara Dickson secured several photographs of Sonoran pronghorn drinking from natural bedrock pools (tinajas) in the Bates Mountains.

Still unknown is how frequently, or under what conditions, Sonoran pronghorn will use freestanding water. Research by Lisa Fox (University of Arizona, Tucson) suggests the forage plants constituting the diet of the pronghorn may meet its water requirements. A previous Trailmaster camera study on neighboring Cabeza Prieta National Wildlife Refuge by Tricia Cutler (University of Arizona, Tucson) failed to document the animal using an artificial water catchment that had been constructed specifically for its use.

The events photographed in Organ Pipe came during a prolonged drought, when animals might have been particularly in need of water. The tinajas used by the pronghorn had received water from the first, meager rains of the summer thunderstorm season. After more extensive rains,

the pronghorn apparently did not revisit this water source, or any others where cameras were stationed. Photographs of a mountain lion visiting the Bates Mountains tinajas the day before the pronghorn suggest that this rare water resource also provides a dependable ambush site for predators. Sonoran pronghorn, and other wildlife, indulge their thirst at some risk

GREAT PLAINS

Disease documented in Badlands sheep

Between 1991 and 1995 research on the Rocky Mountain bighorn sheep population in Badlands National Park (South Dakota) resulted in a decision to restore sheep to areas of unoccupied, suitable habitat. In October 1996, the park translocated twelve ewes and four young rams from the park's Pinnacles herd. All of these sheep survived the transplant and subsequent harsh winter. Three of the four young rams returned to bachelor groups in their origin herd during the spring. By the end of May 1997, nine ewes had given birth to ten lambs. However, between mid-July of last year and mid-March of this year, six of the mother ewes and one spinster ewe died. One of four carcasses recovered was positively diagnosed for epizootic hemorrhagic disease (EHD), a virus more often associated with white-tailed deer. Infected gnats carry the disease.

The Pinnacles herd had been thought to be an appropriate source population; however, following the translocation, the park noted a change of status in the source herd. A ground and air count in October 1997 revealed a skewed ewe-to-ram ratio of about 1:3. While the overall population decline in the source herd may be as much as 50%, no causative factors for the attrition have been found. The USGS Biological Resources Division and the National Park Service continue to evaluate the habitat model and monitor both the translocated and source sheep populations. Plans tentatively call for a translocation of out-of-state animals to found another subband. This is in keeping with the restoration plan to create a metapopulation linking several herds in the Badlands landscape, or, if deemed biologically appropriate, to augment the present population during the next two years.

COLORADO PLATEAU

Grant funds endangered plant monitoring

A 1997 grant from the National Fish and Wildlife Foundation's Native Plant Conservation Initiative allowed botanists to monitor the federally endangered sentry milk-vetch *(Astragalus cremnophylax var. cremnophylax)* and three of its varieties on public and Navajo Nation lands in Arizona. A member of the pea family, the sentry milk-vetch is a dwarf, evergreen, cushion plant that is confined to "ledge pavement," the rimrock habitat overlooking the South Rim of Grand Canyon National Park. In 1990, it was listed when surveys showed it to be declining following decades of trampling by park visitors who crossed the habitat to reach the canyon view. Three other closely related varieties are spatially distinct: (1) the cliff milk-vetch, a species of special concern, is located on Forest Service and Bureau of Land Management lands north of the park, (2) the Hevron milk-vetch is located on the Navajo Nation lands overlooking Marble Canyon, and (3) a newly discovered population, which may prove to be a new variety, is located on the North Rim of the Grand Canyon.

As a result of the grant, permanent monitoring plots have now been established at all four sites. Over 500 plants have been tagged using small, numbered, plastic pennants attached with stainless steel wires. Cartesian coordinates (x and y locations) along the transect have been documented to enable individual plants to be identified should the tags be broken, lost, or removed. Basal cover or size of the plant mats was determined by tracing the perimeter or outline of the plant on clear mylar. The tracing was cut out, weighed, and the area (in grams) determined by dividing the average weight of the mylar per unit area (yielding square centimeters)[1]. Substrate and associated species information was also collected in quarter-meter "Daubenmire" plots. Growth, reproduction, and mortality for each plant mat will be tracked in the coming decades. This demographic work will complement genetic research on the species; the species is threatened by inbreeding depression.

The three varieties of the sentry milk-vetch will be included along with 150 other plants in a *Rare Plants of Arizona* fieldguide currently being coordinated by The Nature Conservancy with the cooperative effort of over 25 botanists throughout the state. This effort is also being funded by a grant for the 1998 National Fish and Wildlife Foundation's Native Plant Conservation Initiative.

[1]For additional information on the methodology, see the 1996 paper "A perimeter tracing method for estimating basal cover: Monitoring the endangered sentry milk-vetch at Grand Canyon National Park, Arizona" by Peter G. Rowlands and Nancy J. Brian. The Southwest Naturalist 41(2):169-178.

GREAT LAKES

Piping Plovers nest at Apostle Islands

After a fifteen year hiatus, the federally endangered Piping Plover has once again nested on Long Island within Apostle Islands National Lakeshore. The lakeshore, consisting of 21 islands and a mainland unit surrounded by Lake Superior in far northwestern Wisconsin, was established in 1970. In 1986, Long Island (now a barrier spit) was added to the lakeshore, in large part to protect nesting Piping Plover habitat. Despite this action, the bird species had not nested in the lakeshore since 1983–that is, until this year.

For years, lakeshore staff and cooperators have been on the lookout for the bird on Long Island in the spring. During migration, they are occasionally seen, but nesting was not occurring. However, in 1998, Sumner Matteson, a Wisconsin Department of Natural Resources (DNR) avian biologist, saw a pair of Piping Plovers exhibiting courtship behavior. A scrape was later found with four eggs. To protect the nest from mammal and avian predators, an exclosure was placed over the nest. It worked–three eggs have successfully hatched.

Protection of these birds has truly been a cooperative effort. Involved are park staff, the Bad River Tribe, the DNR, the U.S. Fish and Wildlife Service, researchers from the University of Minnesota, and The Nature Conservancy. This nest is indeed important, not just for the lakeshore, tribe, and cooperators, but also for the Great Lakes Piping Plover population. Although over 800 pairs nested throughout the Great Lakes historically, no more than 20 pairs have done so in the last 15 years. PS

New Zealand experiments with island sanctuaries

The adverse effects of nonnative plants and animals are universal problems in the preservation of native fauna, flora, and biological diversity of native species. In many places worldwide, introduced predators dominate, and the continued existence of native species, if not endangered or already absent, is threatened. Comprehensive eradication of exotic species is frequently not possible. In its efforts to save local endangered species, the New Zealand government secures offshore islands as protected sanctuaries (Pryde, P.R. 1997. Natural Areas Journal 17(3):248-254). Selected small offshore islands are comprehensively cleared of introduced mammals and, if necessary, revegetated. Declining and endangered native species, particularly endemics, are then released. Initial results on one of three islands, Tiritiri Matangi, are encouraging.

Sheep that had been grazing for almost 100 years had largely denuded this island of vegetation. Rehabilitation of the island began in 1970 with the removal of the Polynesian rat *(Rattus exulans),* which took five years. Between 1984 and 1994, thousands of volunteers revegetated the island with more than 200,000 native trees. Then native bird species, including endangered and even almost extinct species, were reintroduced. The introductions have been so successful that some birds are now relocated to other rehabilitated islands. A rail system on Tiritiri permits visitors to view the relocated species. Other offshore islands are used for the establishment of other types of endemic species such as plants, amphibians, and reptiles.

The creation of island sanctuaries, however, is not without problems and does not guarantee the preservation of species. The maintenance of the islands is labor intensive and costly; the native species are vulnerable to destruction from random events; and migratory species that breed on the island sanctuaries of New Zealand may be threatened elsewhere.

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Culvert design important to vertebrates

Roads and railway tracks are among the main obstacles to movement by land vertebrates. The consequences may be a reduction of genetic diversity from increased inbreeding, risk of local extinction because of population dynamics and catastrophic events, and decreased recolonization. In central Spain, analyses of movements by vertebrates through 17 culverts under roads and railways during one annual cycle revealed that adequately designed culverts aid the conservation of vertebrate populations and can eliminate costly construction of special passages for fauna. Most crossings were by small mammals (77%). The crossings of mammals, including carnivores, did not differ by season, but the number of crossings by reptiles was greater in summer than in other seasons and seemed to depend on animal abundance.

Detritus pits impaired the passage by reptiles. Rabbits and carnivores did not use culverts with detritus pits. The number of crossings by small mammals was lower when roads were surrounded by pasture. The crossing of medium-size mammals (rabbits and carnivores) was affected by the total width of the road and not by the width of the portion of the road used by traffic. The height of boundary fences may prevent access to culverts by some animals. The authors (Yanes, M., J.M. Velasco, and F. Suarez. 1994. Permeability of roads and railways to vertebrates: the importance of culverts. Biological Conservation 71:217-222) recommend that fences be constructed to funnel animals toward culverts but not impede access to them and to eliminate detritus pits or modify them with ramps. Further study of culvert design that eases passage by animals is necessary.

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Buffer zones for nesting eagles researched

Like humankind, wildlife responds psychologically to disturbances before responding behaviorally. Yet, the dimensions of spatial buffer zones to protect wildlife from disturbances–for example, human activities in public parks–may not exceed distances at which wildlife responds with behavior (such as flight). Camp, Sinton, and Knight (1997. Wildlife Society Bulletin 25(3):612-615) used a geographic information system (GIS) and a global positioning system (GPS) to develop spatial buffer zones that included the protection of the view or *viewshed* from six nests of the Golden Eagle in the Phantom Canyon Preserve, Colorado. The recommended buffer zone for a Golden Eagle nest when the birds are rearing young has a 333-meter radius. In the preserve, such buffer zones for the six nests would have encompassed 145 hectares (358 acres). The additional protection of the viewsheds extended the area of the collective buffer zones to 434 ha (1,072 acres). By creating viewsheds for sensitive species–for example, with vegetation that blocks a species' view of disturbances–natural resource managers may improve the regulation of visitors with trails, access to panoramic views, and tours. A viewshed database with information about the distribution of wildlife can be helpful with the evaluation of effects on wildlife from proposed activities for visitors of a park or preserve.

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Small parks significant for biodiversity

Authors M.B. Falkner and T.J. Stohlgren (1997. Evaluating the contribution of small national park areas to regional biodiversity. Natural Areas Journal 17(4):324-330) collected information on species richness of vascular plants, mammals, and birds in 44 national park system units in the former NPS Rocky Mountain Region. The data revealed that because of species composition differences among units, small units add a considerable number of species to regional species lists. An estimated average of 718 species of plants, birds, and mammals inhabit a 100-km^2 (39-mi^2) reserve and includes 84 species unique to the system. If the same amount of land were added to existing units, this would add only 35 species to a large, seven to a medium, and one to a small reserve. Most small parks in the region were initially established

as cultural or historical sites. The authors' study, however, revealed the significance of the smaller units as biological refugia, dispersal corridors, and migration corridors or rest stops. Small units have a disproportionate share of regional biodiversity and an understated role in the conservation of biodiversity in the region.

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A rationale for large ecological reserves

Biological diversity must be protected at genetic, population, and landscape scales, and such protection requires an integrated system of large nature reserves and ecosystem management according to Edward Grumbine (1990. Protecting biological diversity through the greater ecosystem concept. Natural Areas Journal 10(3): 114-120). Merely protecting species fails to capture important elements of biological diversity such as ecosystem patterns and processes. The current network of nature reserves will not protect many species for more than 50 years. A large nature reserve must provide the primary habitat for all native species in the area. It must be sufficiently large to accommodate natural disturbance regimes, and its human occupants and human use must not result in ecological degradation. The reserves will have to be monitored to determine whether management is indeed protecting biological diversity. Preservation of biological diversity with ecosystem management requires consistency and coordination of policy, administration, and techniques.

Ecosystem management presents biological, legal, educational, cultural, and economical problems that will have to be resolved. As yet however, the science for protecting biological diversity is still in its infancy. Citizens of industrial countries are only marginally informed about the magnitude of ecology in the lives of people. Governmental agencies employ few conservation biologists. Managers, politicians, and many citizens do not favor the establishment of large nature reserves and revenues for their maintenance and management. Divergent land management by the USDA Forest Service and the National Park Service must be resolved. Federal agencies must support legislative reform for the protection of biodiversity. An endangered ecosystems act is needed. The public must be educated and persuaded to become party to decisions that bear on the long-term protection of biological diversity. Equal weight cannot be given to all interest groups because many would destroy biological diversity for short-term economic gain. Time to implement the preservation of biological diversity is short.

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Sources of water pollution traced at Buffalo Nat'l River

Water quality monitoring by the National Park Service has shown that Mill Creek contributes 96 percent of the nitrate/nitrite-nitrogen load to the Buffalo River. Analysis of the macroinvertebrate community within the creek demonstrated that this nitrate load detrimentally affects the benthic biota. Consequently, the Park Service, Arkansas Department of Pollution Control and Ecology, U.S. Geological Survey, and Ozark Underground Laboratory launched a series of water resource investigations to learn more about the sources of the pollution. A synoptic survey revealed that nitrate and orthophosphate concentrations continually rise from the mouth of Mill Creek to the Dogpatch springs at its head. Two qualitative dye traces confirmed interbasin transfer of groundwater from the Crooked Creek basin to the springs at Dogpatch. In both traces, fluorescein dye moved over 2.5 miles from injection to recovery point in less than five days.

These preliminary findings justified more detailed studies to determine not only the recharge area for the Dogpatch springs, but also the causal mechanism driving the interbasin transfer. New detailed geologic mapping reveals that the 120-m-thick cherty limestone of the Mississippian Boone Formation is the main host of karst features and the dominant aquifer. This region was mildly deformed, probably during the Pennsylvanian time, by a system of normal and strike-slip faults and associated monoclines that vertically offset the strata from 15 to 120 m. These structures influence the hydrogeology of the Boone Formation by changing its elevation and hydraulic properties. Several large springs in the Buffalo River watershed are spatially associated with structural troughs in the Boone Formation, suggesting that these troughs preferentially drain water from adjoining regions. The Dogpatch springs lie at the head of a 30- to 45-m deep, keel-shaped trough cored by the northeast-striking, right-lateral Elmwood fault zone. The interbasin flow coincides with the area where the trough crosses the watershed boundary. Conceptually, this fault-cored trough gathers recharge from its limbs within the Crooked Creek watershed and allows it to flow southwest across the watershed boundary in a network of solutionally enlarged fractures that envelope the Elmwood fault zone. The exit of groundwater at the Dogpatch springs coincides with a corner-shaped upstep of the Boone caused by intersection of the Elmwood fault zone with the east-striking Cutoff Road normal fault.

A second phase of the study includes quantitative dye tracings to delineate the interbasin recharge area and test the conceptual hydrgeologic model. Chemical analyses are also being conducted at spring and stream sites in an attempt to correlate land-use activities with water quality. Most of the water quality sampling and dye tracing should be completed this summer.

Coauthors of a paper on the studies (David Mott of NPS and Mark Hudson of USGS) will present their findings at two upcoming conferences: (1) "Karst Processes and the Global Carbon Cycle," a collaborative meeting between Mammoth Cave National Park and Western Kentucky University from September 23-25; and (2) "Gambling with Groundwater," a conference sponsored by the International Association of Hydrogeologists in Las Vegas, Nevada from September 27-October 2. Web sites providing additional information on the conferences are located at *http://www2.wku.edu/~grovecg/* and *http://www.uark.edu/depts/geology/faculty/jvbrahana/iah/index.html, respectively.* PS

Vital Signs conference focuses NPS sights on "perpetuity"

By Jean Matthews

A STEREOSCOPIC VISION OF "IN PERPETUITY" (part of the NPS organic mission) began to emerge at the April 1998 Vital Signs conference in Portland, Oregon, attended by more than 150 Pacific-West Region National Park Service people from all walks of the Service. The conference subtitle, "Assessing natural and cultural park resources," encouraged the crossing of discipline and job description boundaries and invited melding of a fragmented mission.

The week-long conference (April 6-10) aimed at a synergistic stewardship to match the awesome synergy of the ecosystems at risk. The presentations, posters, and workshops produced an ecology of effort from experienced workers in the fields of research, maintenance, museums, law enforcement, and superintendency, who discovered a deeper appreciation for the totality of the job that, together, they are doing.

Evaluation of the conference, as revealed in participant ratings, focused heavily on information-sharing and networking as the highest values received. While time overruns came in for the usual share of gripes, the consensus was overwhelmingly positive. Typical comments included:

- "Organized well–especially [good] integration of disciplines;"
- "The best speakers overall for any conference I've attended;"
- "A great experience and a chance to show others what I do;"
- "Networking is always excellent;"
- "It was a great information sharing session;" and
- "A wonderful opportunity to network and share information. Please keep these up."

Figure 1. Vital Signs can mean many things in many different places. Here at Fort Vancouver National Historic Site in Vancouver, Washington, (destination of one of the conference field trips), being alert to vital signs that signal overall condition of a cultural treasure includes a periodic check for decay at the base of the fort's palisades wall. The palisades are cultural, but the decay agents are natural, so vital signs can overlap and bring together the cultural and natural elements of park management.

Field trips (to Mt. St. Helens and to Fort Vancouver National Historic Site [figures 1, 2, and 3]) received rave reviews. So did Richard Sellars' conference keynote (based on his recent book, *Preserving Nature in the National Parks: A History,* reviewed by Gary Davis in the last issue of *Park Science,* 17(2):1,8). Numerous other sessions were also very popular and included: Kathy Jope's grant writing workshop; the non-NPS speakers on relevant topics; information on related projects such as the Northwest Forest Plan; the poster sessions; the integrated approaches to NPS land management problems; and several of the plenary session addresses, notably those by Mike Soukup (Associate Director, Natural Resource Stewardship and Science) and John Reynolds (Pacific-West Regional Director).

The natural resources stewardship mission was described by Gary Davis (Senior Scientist at Channel Islands National Park, California) as conservation of healthy, unimpaired parks, and fixing the fragmented parks that are no longer parts of the larger ecosystems from which they were carved. The objective of the stewardship structure (field operations, applied science, and research) consists of knowing, restoring, maintaining, and protecting, Davis said. "Vital signs," he said, "are reliable early warning signals by which we can measure and detect changes that will impair the structure and functions of ecosystems. Networking with others who are similarly engaged can help us pinpoint and sharpen our predictions."

Stephanie Toothman, Cultural Resources Team Leader for the Columbia-Cascades Support Office, observed that management of cultural resources–a record of human interaction with the environment–parallels that of natural resources. Its disciplines–ethnology, archeology, museum curation, architecture, cultural landscapes, and history–likewise involve research, inventory, and management.

Richard Sellars, conference keynoter, identified the culture of the National Park Service itself as the largest impediment to a scientific natural resources program. As in his book, Sellars made a strong plea for

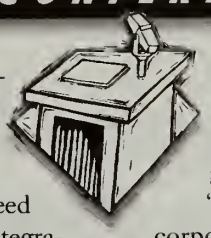
recognition at the NPS director level that "resources preservation is our Service's primary mission and thus should be the primary profession in the Service."

Landscape architecture was the key to the management strategy in the beginning, he said. Preservation was aimed at aesthetics rather than system structure and function. Thus, fire suppression, fish stocking, tourist infrastructure, removal of predators, and road building, all were well established as the primary park mission by the turn of the last century; development and recreation were the early objectives.

Interior Secretary Franklin Lane's decision to borrow science from other agencies rather than installing it as a part of the Park Service contributed to the perception of biologists by the NPS hierarchy as threats to the NPS power structure.

Pacific-West Regional Director Reynolds told the assembled conferees, "I am a strong advocate of full funding and of strengthening the ties between resource stewardship and superintendency. We must implement our full professional grades to protect our functioning resource bases."

He acknowledged the current "atmosphere of need" for better resource protection, and added, "We're the ones who can, and should, be doing that job." And he is committed to getting the money to do it, he said. Parks are threatened by insularity and habitat fragmentation. "We still don't know what we have, but we know enough to know where we need to go. We need natural and cultural resources integration, and we would do well to begin simply by obeying the laws already in existence."



One "small beginning," Reynolds said, "will be to change the standards for superintendent performance. There is no single standard today for resource preservation. I promise you that will change," he told the applauding conferees.

He advised the assemblage to "read every page of Sellars' book. We need to think about it," he said. "It will help us understand why we are the way we are, and that will help us to see what we should be and how to get there."

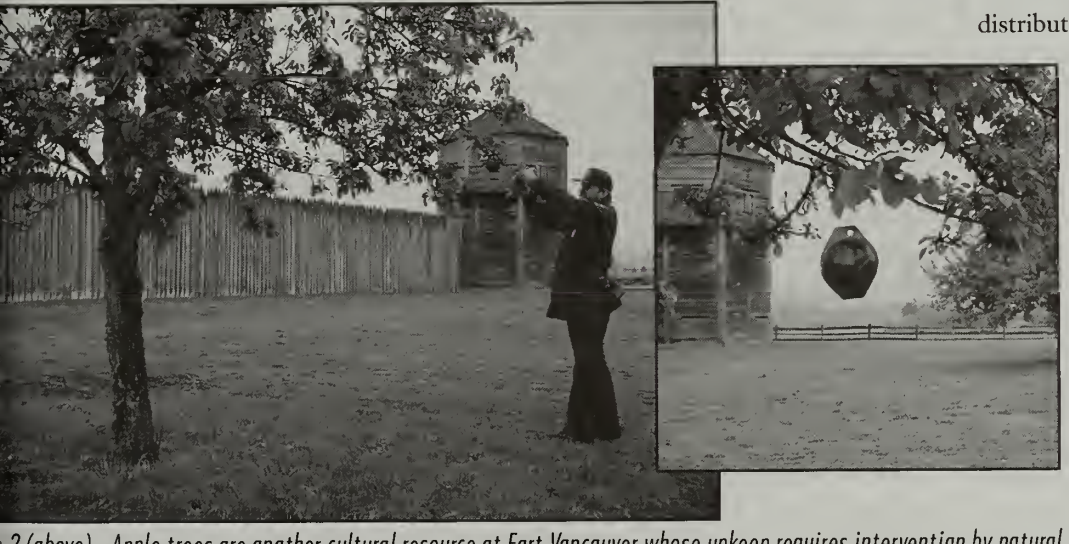
"One of the main funding difficulties," he said, "is that we've trained Congress to believe that we are something that we don't really want to be." He sees a need for a better science delivery system, and tie-ins with countless other potential allies. "A river running through a park gives us access to people along the river all the way to the ocean," he said. There are opportunities for partnerships with business, with other governmental agencies, and with nongovernmental organizations.

"Sell them, educate them, and incorporate them," he said. "Our ranks need to be as diverse as our nation. Diversity is not just about race and profession, it's about ideas, and our highest idea is excellence. We are protecting the excellence that is our country.... We represent the ideal of this nation."

NPS Director Bob Stanton's plan is excellent and complete," Reynolds said; "now how do we sell it to Congress?" This was the question he left with the conference.

He made it clear that his own plan for achieving it rests on excellent research, improved science delivery systems, incorporation of resource management into NPS career ladders that go clear to the top, the education of public and private entities as to their stake in excellence, and the echoing of this developing sentiment in the halls of Congress.

A full conference report, complete with specific recommendations from all five break-out sessions (geographic information systems; fire management and planning; cultural inventory and monitoring; natural inventory and monitoring; research: history, natural and otherwise: and resource treatment and protection), was planned for distribution throughout Pacific-West Region in June. Copies may be had from conference chair Jonathan Bayless at 600 Harrison St., Suite 600, San Francisco, California 94107; (415) 427-1427; FAX (415) 744-4043; e-mail: *jonathan_bayless@nps.gov.* PS

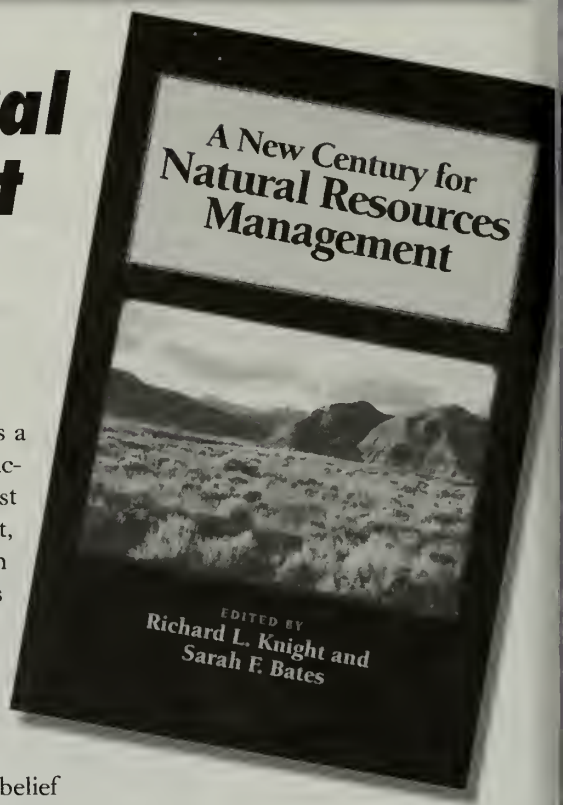


2 (above). Apple trees are another cultural resource at Fort Vancouver whose upkeep requires intervention by natural rce managers. To reduce spoilage of the fruit by apple maggots, resource managers place traps resembling apples (figure ve right) in the trees to control the insect. The look of the trap attracts the insect; no chemical attractant is needed. In ultural park, fruit from the apple trees is used in interpretive demonstrations of the fort's historic period and enjoyed by iblic.

Jean Matthews is the founder and former editor of Park Science. *She is retired and lives in Vancouver, Washington.*

A New Century for Natural Resources Management

Edited by Richard L. Knight and Sarah F. Bates



A book review by Craig L. Shafer

Many books on conservation topics have poorly integrated chapters, are hard to read, are often dull, and end up serving primarily as references for a narrow, technical audience. The 1995 Island Press book *A New Century for Natural Resources Management,* edited by Richard L. Knight and Sarah F. Bates, suffers from none of this. Good planning and meticulous editing resulted in a logical progression of short, interesting, easy-to-read reviews and essays by diverse topic authorities. This book ought to attract a very wide readership that includes researchers, natural resource management specialists, land managers and planners, policy makers, legislators, environmentalists, and students.

The book's theme–that the way agencies view natural resource management must continue to diverge from the utilitarian tradition of the 19th century–is timely. The twenty-one chapter volume illustrates that views and practices in natural resource management are always changing; for these authors, change is too slow because of the challenges natural resource agencies will face after the millennium. Organized in three sections, the book traces the history and conflicts related to natural resource management before emphasizing new approaches for the future.

The first six chapters focus on U.S. history. **Chapter 1** by Curt Meine is a well-documented account that intermeshes the emergence of forestry, agriculture, range-wildlife-fisheries management, recreation and wilderness with the establishment of the early federal agencies and the influence of Gifford Pinchot, John Muir, and Aldo Leopold. Meine demonstrates that the resource concept (e.g., forests, wildlife) arose first; agencies then formed around such concepts, and the academic natural resource disciplines came later.

Chapter 2 by Robert H. Nelson is a longer analysis of the creation, early activities, and responsibilities of Forest Service, Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service. Nelson believes the agencies started out with the progressive era ideal of "scientific" management, and even though their actions quickly became politicized, the ideal still shapes thinking today. The author argues that the outdated belief that economic progress is inevitable with science guiding resource management should be replaced by a more "values-oriented" model.

Stan H. Anderson's **Chapter 3** focuses on the concept of "sustained yield" as practiced in forestry, range, wildlife, and fisheries management. Perhaps deliberately, the author avoids dealing with the controversial concept of "sustainability."

In **Chapter 4,** Dale Heine analyzes the history of American natural resources education. He observes that both the western "ranger factories" and the midwestern and eastern schools prepared students for jobs with other professionals, all with similar backgrounds and speaking the same jargon. This type of education, perhaps indoctrination, he argues, was found at universities claiming to be sanctuaries for independent thinking. Government employment standards, professional association certification requirements, and special interest groups shaped these academic requirements. The traditional B.S.-B.A. requirements of the 1960s represent the formal educational background of many of today's senior land managers. But today, "many new students soon foresee their education as too prescribed, management-production focused, too narrow, and impersonal," causing them to drop out. Although 4,000 university degrees in natural resources are awarded annually, the author implies that many students will not be prepared for the next century, especially as leaders in policy development.

Chapter 5 by Gloria E. Helfand and Peter Berck reviews "traditional" concepts in natural resource economics. Non-economists will find it uncommonly user-friendly. They argue that environmental degradation results when policies violate basic economic principles like when the Forest Service sells timber on public land below cost.

Next, in **Chapter 6,** Eric Katz traces the evolution of natural resource ethics. The author examines in detail the highly influential views of John Locke, the famous 17th century philosopher, who thought that nature had value only when used as "property." Locke's views have been used to undermine environmental legislation (Duncan 1996). The author might have given more emphasis to how Locke's work has been interpreted to support conservation. Some claim it argues for restrictions on private land use if counter to the public good (Shrader-Frechette and McCoy 1993). Locke influenced thinking of that age.

The second section of the book focuses on conflicts. Relying on his uncommon insight, David W. Orr's essay in **Chapter 7** is about a "sense of place." Orr begins by giv-

ing a personal account of growing up in small-town western Pennsylvania. He explains, "we no longer have a deep sense of place." His honesty in writing about the economics of place is persuasive. "The disorder of ecosystems reflects a prior disorder of mind, values, and thought that...put humanity outside its ecological context.... People need healthy food, shelter, clothing...a vital civic culture...and wildness. But they are increasingly offered fantasy for reality, junk for quality, convenience for self-reliance, consumption for community, and stuff rather than spirit. Business spends $120 billion a year to convince us that this is good.... Our economy has not...fostered largeness of heart or spirit.... And it is not ecologically sustainable." Orr's basic message is profound: people will take more responsibility for their environment when they sense being part of a human community, a feeling being rapidly lost in the United States.

Chapter 8, by Mark W. Brunson and James J. Kennedy, discusses dominant use practiced by the Forest Service, National Park Service, the Bureau of Land Management, and the Fish and Wildlife Service, why social values changed, and how land management agencies responded. In later decades, our technically trained land managers found themselves unprepared for the jobs they landed and were surprised at the skills required. Examples include public relations, negotiating, writing for the public, skills usually advocated for lawyers, legislators, or journalists. In addition, land managers after mid-century encountered new stresses: living with locals in rural western small towns, new laws giving one agency power over another's actions, and employees calling for new paradigms.

The latter meshes with Jeff DeBonis' **Chapter 9**, which shares his experience as a new Forest Service employee and his subsequent disillusionment with their practice of overcutting timber. While there, he formed the Association for Forest Service Employees for Environmental Responsibility (AFSEEE). In 1993, he left that organization to form Public Employees for Environmental Responsibility (PEER). There, disillusioned public employees found a sanctuary of like-minded people and a vehicle to lobby for their points of view. Today, PEER has 10,000 paying members and Jeff has moved on.

Next, in **Chapter 10**, Winifred B. Kessler and Hal Salwasser describe the creation of the 1990 Forest Service "New Perspectives" initiative, which they say led to the June 1992 adoption of an "ecological approach" in Forest Service management, a step towards "ecosystem management." However, all agencies have a long way to go before qualifying as acknowledged ecosystem management practitioners, at least based on some definitions (Grumbine 1994). The December 1995 Ecological Stewardship Workshop in Tucson, Arizona (*Park Science,* **16(2)**:13-15) was former Forest Service Chief Jack Ward Thomas' pet initiative.

Chapter 11 provides Rupert Culter's thorough account of the role of environmental NGOs (nongovernmental organizations). Quoting John Rousch, we learn that only about 50 have budgets in the tens of million of dollars. The undisputed giant is the National Wildlife Federation, whose 5.3 million supporters allowed them to spend $97 million in just 1993. The author acknowledges tension between NGO amateurism and agency-industry professionalism but thinks the gap is closing rapidly. Recent analyses produced two primary NGO criticisms–lack of collaboration and little attention to the economic well-being of local people–but we learn nothing else about what NGOs are doing wrong. Since the book provides a large dose of agency criticism, such treatment is unbalanced.

In **Chapter 12**, Vawter Parker reviews the history of public interest lawyers taking agencies to court. For example, the Sierra Club instigated the famous 1969 "Mineral King" case. Although the Disney Corporation planned massive development on Forest Service land, the conflict finally ended when Congress added Mineral King to Sequoia National Park in 1978.

In **Chapter 13,** John B. Loomis documents that government cost-benefit analyses taking into account more than just "marketable goods" was not prominent until the 1960s and reviews techniques to value such "externalities."

Thomas Michael Powers' **Chapter 14** was very enlightening, though heavy in places for non-economists. The old "extractive" economic model may indeed be flawed, and Powers provides some easy-to-understand supportive examples. Relying on graphics, Powers illustrates that the old model predicted the economic demise of some small western communities after their resource extraction industries were curtailed. But this prediction never happened; some towns even became more prosperous than before! Powers lists economic trends that may account for this surprising result and then proposes an updated economic model–one placing far more emphasis on the degree people value environmental quality in their community and surrounding region. Threatened western rural communities reared on this old model could gain insight here or in the author's 1996 book.

A New Century for Natural Resources Management

1995 Island Press

432 pages
Tables, figures, index

Hardcover:
ISBN 1-55963-261-5
$55.00

Paperback:
ISBN 1-55963-262-3
$32.00

The book's third and final section emphasizes new approaches. **Chapter 15** by S.T.A. Pickett and R.S. Ostfeld is timely and analyzes a topic Pickett has addressed before (Pickett et al. 1992). The authors argue that the "classical" (or equilibrium) ecological paradigm has failed and should be replaced with their "flux of nature" paradigm. The authors say their flux model nullified the long-held "balance of nature" metaphor. As they point out, this reexamination has been ongoing for a long time. Scientists working for the Park Service in the 1970s questioned the notion of "steady

continued on page 12

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states." Botkin dealt the "balance" idea its biggest blow in 1990. Pickett and Ostfeld perceive some management strategies are driven by the classical model, including "nature knows best" hands-off management. Vestiges of such thinking can be seen at Yellowstone and elsewhere.

Next, R.L. Knight and T.L. George, in **Chapter 16**, contrast traditional biotic "resources management" disciplines with ideas subsumed under the new field of conservation biology, providing a brief sketch for those unfamiliar with its emergence. The authors do not recommend abandoning traditional natural resource management approaches but supplementing them with conservation biology's more holistic, landscape-process awareness.

In **Chapter 17**, Susan Jacobson provides her thoughts about producing better trained natural resource managers. Predictably, she believes a conservation biology or sustainable development perspective provides a better academic focus than the traditional resource disciplines. She recommends more disciplinary breadth, training in economics and social skills, etc., and legitimately questions whether universities can handle this need. This point is key. For future conservation biologists, Noss (1997) gave universities a scathing assessment, with some notable exceptions. Readers with land management experience may laugh at any suggestion that new resource managers can leave a university with all the knowledge and skills they will ever need. Only in this century, have universities tried to fill a need once reserved for practical experience, apprenticeships, and continued personal study. Jacobson's recommendations are sound, she is well acquainted with the literature (Jacobsen and McDuff 1998), but they lack some insight derived from personal work experience.

In **Chapter 18**, James J. Kennedy and Jack Ward Thomas propose a new model for managing natural resources–manage for social value instead of things! Readers might not reach this awareness on their own. The authors believe their model reflects what students actually encounter on the job, often to their great surprise. For NPS readers, "social conflict management" may sound familiar. The authors do not advocate a "consumer-is-always-right code." They do advocate honoring diverse values and participating in value evolution. Many agencies already do this through interpretation, public hearings and Congressional testimony, publications, videos, TV and radio interviews, etc.

Robert Costanza uses **Chapter 19** to review the new transdisciplinary, problem-focused field of "ecological economics," which he was instrumental in developing. He highlights some key ideas in his previous papers. The presentation is easy to follow.

In **Chapter 20**, Holmes Rolston offers his views on a global economic ethic. However, it is difficult to understand the real, tangible benefits of continual articulation of slightly improved versions of a nature ethic, at least for the book's intended audience. If most land managers understand Aldo Leopold's "land ethic" in the 1949 book *A Sand County Almanac,* they will not be far off course.

Edward Grumbine in **Chapter 21** begins with a Cascades backcountry bear story to highlight his disappointment that some critical population viability factors were not addressed by the Interagency Grizzly Bear Study Committee in 1990, or fixed in a 1992 document revision. The author says the private Greater Ecosystem Alliance did a much better job using similar data. This could be, because the viability determinants he highlights were highly significant. However, to attribute the two results to different organizational value systems (private sector versus government) is speculation. Grumbine has provided valuable technical guidance and insight in previous work (Grumbine 1992), but it unfortunately again gets intermixed with black-and-white essay generalizations driven by his frustration with agencies. The author repeats his five primary "ecosystem management" principles from his significant 1994 paper.

The book ends abruptly with a one-page synopsis. Although each section of the book begins with a useful synthesis, top officials in agencies and elsewhere are conditioned to look for "strategies." Because of this expectation, however difficult or even scientifically naive, the book should have ended by bringing more detailed focus to more of the dominant ideas presented in its many chapters.

A New Century for Natural Resources Management is refreshing for a multiauthored volume. Most chapters are very good and each should teach most readers something new. Unfortunately, those who most need its insights are unlikely to read it, e.g., agency heads, second-or third-level Washington or regional office agency lieutenants, some oversight-providing political appointees, the Congress, natural resource extraction industry officials, western small-town communities, land-rights activists, and some field managers with formal academic training from the 1960s or earlier who have been able to keep up. They should. PS

Craig L. Shafer (craig_shafer@nps.gov) *is an Ecologist with the NPS Natural Resource Stewardship and Science Directorate in Washington, D.C.*

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Profile of the USGS National Wetlands Research Center

Figure 1. A wetlands ecologist from the National Wetlands Research Center measures soil elevations for baseline assessments at Big Thicket National Preserve, Texas. Known as a sedimentation-erosion table, the device depicted is used in conjunction with marker horizon techniques to measure accretion, erosion, and subsidence at wetland sites. Data are being collected to determine the sediment budget for the Neches River floodplain as part of a larger study of water quality.

By Daryl McGrath

Editor's Note: *This is the second profile to appear in* Park Science *of a research center operated by the USGS Biological Resources Division (see* ***15(3):12-13*** *for a profile of the Midcontinent Ecological Science Center in Fort Collins, Colorado). One of 17 science and technology centers nationwide, the National Wetlands Research Center is a valuable resource for NPS resource managers with research or technical assistance needs related to wetlands. The entire network of centers is profiled online at* http://biology.usgs.gov/pub_aff/centers.html.

If you have wetlands in your park and would like to know more about them, the National Wetlands Research Center (NWRC) in Lafayette, Louisiana, has an ecologist, geographer, or information specialist for you. The NWRC's mission is to develop and disseminate scientific information needed to understand the ecology and values of the nation's wetlands and to manage and restore wetland habitats and associated plant and animal communities. The 71,000-square-foot headquarters is located in the research park of the University of Southwestern Louisiana. The Center also maintains project offices in Gulf Breeze, Florida, Baton Rouge, Louisiana, and Nacogdoches, Texas. Although NWRC research is concentrated in the southeastern United States (the National Park Service administers nearly 50 units in the Atlantic and Gulf Coast clusters in the Southeast Region), the center currently has or previously has had projects or study sites in almost all 50 states, in addition to Mexico, Honduras, Guatemala, England, Italy, Germany, Finland, Micronesia, and Australia.

The NWRC is one of 17 science and technology centers of the U.S. Geological Survey's (USGS) Biological Resources Division (formerly the National Biological Service). The Center originated as the National Coastal Ecosystems Team in 1975 as part of the U.S. Fish and Wildlife Service's Office of Biological Services and was headquartered at NASA's Stennis Space Center near Bay St. Louis, Mississippi. The Team moved to Slidell, Louisiana, in 1979, and in 1986, it was given a research mission and renamed the National Wetlands Research Center. In 1992, NWRC moved its headquarters to Lafayette, and it became part of the National Biological Service (NBS) in 1993. In October 1996, NWRC joined the USGS when the NBS became the Biological Resources Division (BRD) of that agency.

The Biological Resources Division's mission is to work with others to provide the scientific understanding and technologies needed to support the sound management and conservation of the nation's biological resources. While it seeks to provide reliable scientific information for all American citizens, BRD recognizes a special obligation to serve the biological information needs of Department of the Interior bureaus, particularly the National Park Service and U.S. Fish and Wildlife Service. The BRD is led by Chief Biologist Denny Fenn, who started his career in the National Park Service in 1972 as a soil scientist and eventually served as NPS Acting Associate Director for Natural Resources before joining NBS.

The NWRC performs an important role in wetlands research. Wetlands in the United States continue to disappear at an alarming rate, particularly in Louisiana, where coastal wetland loss averages more than 35 square miles per year. Additionally, changes in wetland hydrology or community composition are often propagated up the food web, affecting commercially and recreationally important species such as shellfish, finfish, and waterfowl. Studies at NWRC contribute to scientific understanding of the factors influencing wetland loss and are used to develop management strategies for mitigating those losses. NWRC researchers also study the effects of natural and human-induced impacts on wetlands and the effects wetland changes have on animal communities and populations.

Center organization

The NWRC is staffed by about 150 federal and contract employees who have a broad range of scientific and technical expertise. Research areas and services include plant, animal, and wetland ecology; mapping; remote sensing; modeling; geographic information systems (GIS); computer and electronic technologies; and information technologies and services. The Center is divided into four scientific branches: Animal Ecology, Forest Ecology, Spatial Analysis, and Wetland Ecology, and two offices: Technical Support and Administration.

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NWRC continued from page 13

The Animal Ecology Branch focuses on the survival of animal species and quality of habitat through studies of population dynamics, inventorying and surveying, examining effects of environmental contaminants on ecosystem food webs, and improving statistical models for ecological research. Animal ecologists study migratory bird populations that are declining because of habitat loss or alteration; resident shorebirds and waterfowl that winter in gulf coast wetlands; and the effects of habitat change on songbirds that stop over in coastal wetlands on their way to the neotropics. In a recent study, researchers developed a GIS-based spatial model to study the behavioral responses to factors influencing distribution of the Northern Pintail duck wintering in the lower Mississippi River region.

The Forest Ecology Branch studies the loss, fragmentation, and degradation of forested wetlands from hydrologic alterations and past management practices. Scientists focus on bottomland hardwood forests, cypress-tupelo swamps, pine savannas, coastal oak ridge (cheniers) forests, and mangrove forests, which together account for more than a third of all wetlands remaining in the contiguous United States. They investigate the functions of southern forested wetlands, develop computer models to forecast alterations in forest composition as a result of environmental change, explore the potential for reforestation and forest restoration, and study the annual growth rings of trees to assess the effects of ecological disturbances on forested wetlands. One ongoing study has identified and is seeking to cultivate salt-tolerant strains of baldcypress for use in wetland forest restoration.

Researchers in the Spatial Analysis Branch help fulfill the information needs of natural resource managers by developing and maintaining databases of landcover satellite images for the Southeast, contaminants for gulf coast estuaries, breeding birds for Louisiana, hydrology and vegetation for the lower Mississippi River valley, and the status and trends (1956-93) of wetlands, uplands, and seagrasses along the Gulf of Mexico. Spatial Analysis Branch personnel develop geographic information systems to analyze trends, produce natural resource inventories, and create simulation models. They also conduct remote sensing studies to develop all-weather, day-and-night monitoring tools and map habitats to spatially represent ecological, biological, and other data. Recent remote sensing studies have shown that satellite radar can detect coastal flooding and can be used to monitor the recovery of marshes from burning. In addition to their research, representatives from the Spatial Analysis Branch co-chair the $20 million monitoring program of the Coastal Wetlands Planning, Protection, and Restoration Act with the Louisiana Department of Natural Resources to monitor over 80 wetland restoration projects.

The Wetland Ecology Branch conducts research related to sustainable management and restoration of the nation's coastal saltwater wetlands, coastal and inland freshwater wetlands, submerged aquatic ecosystems, and coastal prairies of Texas (fig. 1) and Louisiana (of which only one percent remains of the 200 million acres present during Colonial times). Wetland ecologists study factors threatening coastal ecosystems and investigate how to stabilize, restore, and manage the coastal landscape. To better understand influences leading to wetland loss, researchers investigate global climate change, accretion and subsidence, herbivory, saltwater intrusion, shading, and disturbances by storm or fire. Studies performed by the Wetland Ecology Branch have demonstrated that estimates for the potential of coastal wetland submergence based on accretion data may underestimate that potential by neglecting the effects of subsidence.

The center's Technical Support Office provides numerous skills that support both the center's and BRD's scientific missions, including technical writing and editing, information management, computer operations, graphics, and education and outreach. Also, the Center's research library, which catalogs and holds many state and federal reports considered as gray literature, is managed by this office. The library is currently engaged in research with the University of Southwestern Louisiana to improve electronic access to environmental information. Technical Support Office staff frequently travel to various events in Louisiana and elsewhere to educate the public about the benefits of wetlands. The NWRC publications staff has edited and produced about 500 technical and series reports and has been instrumental in producing the NBS publication *Our Living Resources* report and the USGS report *Status and Trends of the Nation's Biological Resources*, in addition to the publications *Restless Ribbons of Sand: Atlantic & Gulf Coastal Barriers*, *The Fragile Fringe: Coastal Wetlands of the Continental United States*, and *Willful Winds: Hurricane Andrew and Louisiana's Coast*. The center has won several national and international awards for its publications.

Other services the NWRC offers are conference facilities, tours of the Center, educational programs for local schools and other organizations, a seminar series, and a training workshop series sponsored by the Spatial Analysis Branch, Mid-Continent Mapping Center, and University of Southwestern Louisiana. Schedules for the seminar series and workshop series are available on the NWRC website at *http://www.nwrc.usgs.gov/* under What's New.

Obtaining assistance

The NWRC offers technical assistance in most of its areas of expertise and often relies on cooperative projects to carry out its mission. To initiate a research project with NWRC scientists, contact the appropriate branch chief at the phone number or e-mail address listed in the table (page 15) of research specialties and recent projects. Funding for cooperative research may depend upon current research budgets and planned projects, and parks requesting cooperative projects may be required to provide some funding. Long-term projects may require an interagency agreement or memorandum of understanding. Projects with broad applicability (that is, applicable beyond the boundaries of the requesting park) stand a better chance of being funded or may be funded at a higher level. Regardless of funding considerations, however, the staff of NWRC want to hear from you if you have a wetland problem you would like to discuss. For more information on who to contact or on the areas of expertise at NWRC, consult the Table or visit the center's website. PS

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Table 1

National Wetlands Research Center branches, research areas or services, and ongoing or recent NPS-related projects

Branch	Research Areas or Services	Ongoing/Recent NPS-Related Proj.
Animal Ecology Branch Carroll L. Cordes, Branch Chief 318-266-8654 carroll_cordes@usgs.gov	Ecosystem analysis, environmental electronics engineering, population ecology, and statistical and laboratory support.	Modeling big game populations at Yellowstone National Park (Bruce Pugesek);vegetation survey of Big Bend National Park and the Sierra del Carmen Protected Area in Mexico (Carroll Cordes).
Forest Ecology Branch Virginia R. Burkett, Branch Chief 318-266-8636 virginia_burkett@usgs.gov	Computer modeling, conservation genetics, dendroecology, functions and processes of forests, and reforestation and forest restoration.	Development of a natural resources database, GIS, & predictive computer model to evaluate ecosystem management for surface water and nutria control at Jean Lafitte National Historical Park and Preserve (Tom Doyle); assessment of neotropical bird use on a landscape scale at Big Bend National Park (Wylie Barrow); effects of climate change on forests at Big Thicket National Preserve (cooperative project with Paul Harcombe of Rice University); mangrove community dynamics at Everglades National Park (Tom Doyle).
Spatial Analysis Branch James B. Johnston, Branch Chief 318-266-8556 jimmy_johnston@usgs.gov	Geographic information systems, National Spatial Data Infrastructure, photogrammetry and cartography, remote sensing, GIS-based ecosystem assessment and modeling, and spatial analysis training.	Habitat mapping at Jean Lafitte National Historical Park and Preserve (John Barras); seagrass mapping at Gulf Islands National Seashore (Larry Handley).
Technical Support Office Gaye S. Farris, Office Chief 318-266-8540 gaye_farris@usgs.gov	Information management, outreach, library, technical editing, visual information, and computer support and applications.	Library services (Judy Buys); editing and layout of scientific and technical reports in the report series (Beth Vairin); graphics, exhibits, and multimedia (Sue Lauritzen); informational materials for wetland education workshops at Jean Lafitte National Historical Park and Preserve (Susan Horton); computer support and applications (Jim Capezza).
Wetland Ecology Branch Carroll L. Cordes, Branch Chief (Acting) 318-266-8654 carroll_cordes@usgs.gov	Accretion, subsidence, and sea-level rise, coastal prairie management and restoration, global climate change, marsh management and restoration, nutrient dynamics and biogeochemical cycling, plant community dynamics, and submerged aquatic vegetation.	Baseline assessments of ecological processes, water quality, and suspended sediment in aquatic communities at Congaree Swamp National Monument and Big Thicket National Preserve (Lee Foote and Bill Rizzo); assessment of baseline sedimentation rates at Big Thicket National Preserve and Congaree Swamp National Monument (Don Cahoon).

Visitor information continued from cover

Visitor-related information inventoried

In preparing for this monitoring and evaluation plan, we conducted a baseline study of existing, relevant, visitor-related information available in the 50 park units included in the Recreation Fee Demonstration Program. The purpose of this study was to assess the potential for conducting pre- and post-treatment tests of the new fee system, and to select park units for study that had adequate baseline data available. The overall evaluation project will examine (among other things) the effects of fee changes on visitation patterns and visitor experiences, and their effects on local economies. This paper briefly summarizes the findings of the baseline study.

Methods

The baseline study began by selecting relevant visitor-related variables to be included in an inventory of the 50 park units. This was done in conjunction with the NPS Social Science Program. Eleven variables were selected as shown in figure 2. The specific objective of the inventory was to determine which park units had information on these variables that had been collected sometime between 1990 and 1996.

The inventory was conducted using four approaches. First, a fax requesting information was sent to the office of the superintendent of each park unit. Park units were given the option of faxing back their responses or waiting to be contacted by telephone. Park units that had not responded within three business days were called daily until the information requested had been received. Second, key sources of social science information within the NPS were contacted for inventory data. These sources included regional science liaisons, the Visitor Services Project, the Public Use Statistics Program Center, and the NPS Social Science Program in Washington, D.C. Third, researchers known to be associated with the Park Service were contacted. These included cooperative park studies units, the Biological Resources Division of the U.S. Geological Survey, and academic institutions. Finally, a literature review was conducted using electronic databases and the World Wide Web.

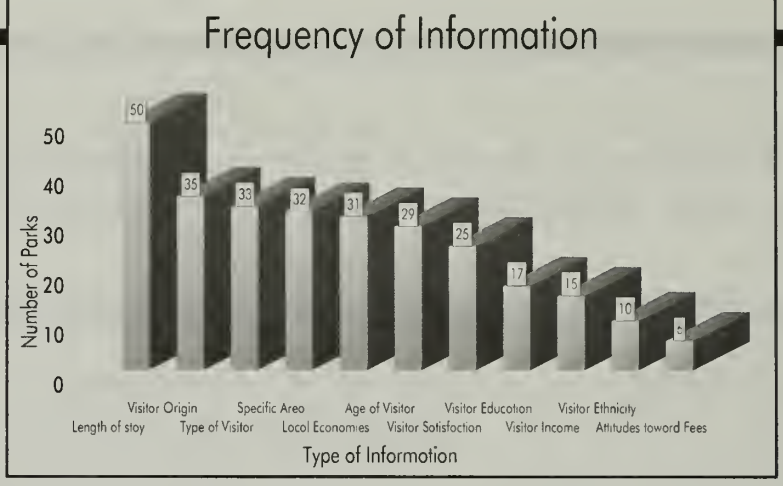

Figure 2. Eleven vi information variab were inventoried i 50 Recreation Fee Demonstration Pro parks. The objecti the inventory was determine which p hod information or these variables, collected sometim between 1990 and

Information spotty

Study findings were compiled into a summary matrix that illustrates the availability of data on each of the 11 study variables for each of the 50 park units. Two conclusions were evident from this matrix. First, availability of visitor information is spotty at best. Only 51.5 percent of the matrix cells indicate data availability. However, this figure may overstate the case. In many instances, available data are very limited in their spatial or temporal character. For example, most data were collected for only one of the six years covered in the study, some were collected in only one season, some were collected for only one type of visitor, and some were collected for only one area within the park unit. Several park units had data on most of the 11 variables, but several park units had no data with the exception of length of stay, which is required for visitor use reporting.

Figure 2 illustrates the relative and absolute frequencies of availability for each of the 11 study variables. Nearly all of these variables should be considered basic to park management as they describe fundamental characteristics of park use and users. Information on park use patterns is important in planning and designing park facilities and services, including planning for visitor and resource protection. Visitor satisfaction is an important component of understanding the visitor experience and how management actions might add to or detract from the quality of the park experience. Knowledge of the economic impacts of park visitation on local economies is vital in maintaining productive relationships with surrounding communities.

Length of stay was the only study variable available to all park units included in the sample; this information is required to estimate annual visitation. However, this information is collected only infrequently. Some measure of visitor satisfaction is available in only half of study park units. Basic visitor characteristics, including education, income and ethnicity, are available in only a small minority of park units. These latter types of data are likely to become more important as society becomes increasingly concerned with matters of cultural diversity, social equity, and justice. To what extent do visitors to the national park system reflect society at large? How well do NPS facilities and services meet the needs of traditionally under-represented groups?

Figure 3 illustrates the sources of social science information. The numbers shown are the sources of each variable for each park unit. The numbers are slightly higher than might he expected because there are occasionally multiple sources for some variables. Scientists affiliated with academic institutions are the most common source of information. However, three NPS programs–the Public Use Statistics Program Center, cooperative park studies units, and the Visitor Services Project–account for nearly half of all available information. Other sources of information are highly varied.

Visitor-related information should extend beyond basic, descriptive patterns of visitor use, i.e., where visitors go, how long they stay, and what activities they participate in

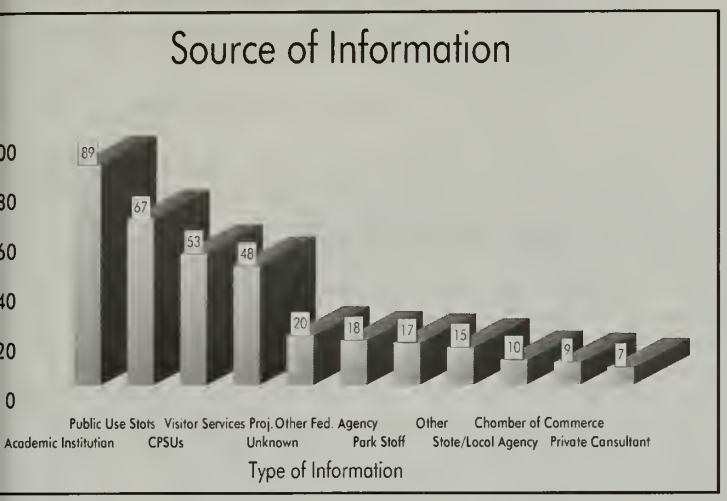

Figure 3. Visitor information is collected through various mechanisms. Numbers indicate the sources of each information variable for each of the 50 park units surveyed. The numbers are slightly higher than might be expected because multiple sources for some variables exist.

Findings troubling

If national park management truly implies visitor management, then the findings from this study are troubling. Though the study was not designed to be a comprehensive assessment of the status of social science information in the national park system, it offers insights into this issue. Enlightened and effective park management requires knowledge and understanding of visitors and other publics. In many, perhaps most, park units, much of this information–that concerning visitors–is largely unavailable. This problem extends beyond visitor management per se. Contemporary paradigms of public land management, including ecosystem management, conservation biology, and human ecology require integration and synthesis of natural and social science information. Lack of social science information suggests that this type of collaboration may be problematic.

The past several years have witnessed numerous calls for a greater emphasis on science–including social science–in the national parks (e.g., National Parks and Conservation Association 1989; National Park Service 1992; National Research Council 1992; National Park Service 1993; National Research Council 1993). The recent formulation of a new social science plan for the National Park Service is an encouraging step in this direction (National Park Service 1996). Part of this plan included a review of social science studies in the national park system during the same general time period (1990-1995) covered by the survey reported here. This review also reported a relatively low level of visitor-related research; an average of only 25 studies were completed each year across the national park system.

The study reported in this paper has two important limitations. First, it does not encompass all social science research in the national park system. It focuses only on visitor-related research and information. Second, the 50 parks included in the sample were chosen for their inclusion in the Recreation Fee Demonstration Program, not because they were representative of the national park system as a whole. However, the park units studied include a wide diversity of type, size, and geographic location.

Recommendations

Study findings lead to two broad recommendations. First, information on visitors to the national park system needs to be collected on a more regular and systematic basis. Only one of the eleven variables addressed in this study–length of stay–is collected at all sample parks. This variable is required for public use reporting. It is apparent that when there is no policy or program directing collection of visitor use information, this information is largely unavailable to park managers. Second, visitor-related information should extend beyond basic, descriptive patterns of visitor use–where visitors go, how long they stay, and what activities they participate in. Visitor satisfaction, motivations, attitudes toward management, and other experiential variables are needed to understand and manage visitors–and parks–more effectively. PS

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Visitor satisfaction, motivations, attitudes toward management, and other experiential variables are needed to understand and manage visitors and parks more effectively

Figure 1. The study at Rocky Mountain National Park used a technique called visitor employed photography. The researchers compared the attitudes of backpackers and day users toward park management, human-habituated wildlife, and human impacts. Both the day user and backpacker groups studied considered park scenery a positive and important feature of their park visit.

Attitudes of backpackers and casual day visitors in Rocky Mountain National Park

By Sarah Flick and Jonathan Taylor

The Biological Resources Division of the U.S. Geological Survey and the National Park Service conducted a study at Rocky Mountain National Park (Colorado) to determine the aspects of the park that were most important to visitors (Taylor et al. 1995a, b). We felt that it would be useful for land managers to know if the needs of certain groups of visitors are being met better than others during trips to the park and whether different groups of visitors are seeking experiences that conflict with each other. Park visitors were grouped into four categories–backpackers, day hikers, car campers, and tourists who were casually visiting for one day (day users). Previously, we had compared the four groups' attitudes towards natural features such as mountain vistas, water bodies, wildlife, and vegetation (Taylor et al. 1995a, b). In this study we compared backpackers' and day users' attitudes about park management, human-habituated wildlife, and human impacts on the environment. We chose backpackers and day users because preliminary analyses determined that these were the two groups that utilized the park most differently from each other.

Methods

During July and September 1993, we passed out 50 single-use, 12-exposure cameras to backpackers and another 50 to day users at the start of their park visit. The participants were asked to photograph the scenes, features, or situations within the park that had the most important effects on their trip. Participants were also given a log in which they recorded, for each photograph, why they had taken it, where it was taken, its subject, and whether the subject had a positive or negative effect on their trip. This method, called visitor employed photography is discussed in Taylor et al. (1995b). Participants were mailed a copy of their photographs, along with a follow-up survey that contained a list of park features that participants rated 1 to 10 on a scale of importance to their experience at the park.

What participants photographed, to some extent, was dependent upon where they went, and on what they happened to see. However, there is a paved road system through several areas of the park, and numerous trails of varying levels of difficulty. There are roads, trails and parking lots adjacent to water, mountain vistas, meadows, areas where animals congregate, and park buildings. All of the participants, therefore, could be assumed to have access to many of the same sorts of features, and we made some assumptions based on the photographs. For instance, if a person took no photographs of streams they probably did not find streams as important as a person who took six photographs of streams.

Results and discussion

Importance ratings

The park features that participants rated in the follow-up survey according to "importance to [their] experience at the park" can be grouped into two categories: (1) management improvements such as campgrounds, trails, and paved roads, and (2) natural features such as wildlife, lakes, wildflowers, and mountain vistas. The ratings showed that both groups highly valued the natural features (fig. 1), but there were significant differences in how the groups rated two of the management improvements–paved roads and campgrounds. Thirty percent of the day users felt that paved roads were important to their experience at the park while only 11% of the backpackers felt the same. On the other hand, 53% of the

Figure 2 (left). Bath groups photographed nearly equal numbers of park management features, but focused on different ones. For example, backpackers photographed more trails; day users more roads.

Figure 3 (below). Backpackers shot far fewer photographs of animals than day users. The data indicate that viewing animals that are accustomed to crowds of humans was an important part of the day users' experience but not of the backpackers'.

backpackers rated paved roads as unimportant, while only 9.5% of the day users did so (X^2 =24.218, p<0.001). Fifty six percent of the day users rated campgrounds as unimportant compared to 14% of the backpackers. One other difference was notable: more day users (35%) than backpackers (19%) felt that well-maintained trails were important.

Management features

Day users and backpackers took almost the same number of photographs of management features (fig. 2; day users n=68; backpackers n=63), and both took management photographs that were mostly positive (81% for day users, 83% for backpackers), but they valued different aspects of management. For backpackers, the most photographed management features were trails (n=25), and for seven of these photographs they wrote that they liked the trail because it was primitive, narrow, or unimproved. Only ten of the day users photographed an unimproved trail, and none of them praised one. Three of them, however, wrote that they appreciated trails that were wide or flat, and two day users photographed trails that they felt should be further developed so that they would be easier to walk on.

Roads/lookouts/parking lots made up the most photographed management feature category for day users (n=25). Most of these photographs were positive, praising road smoothness and exciting turns, and the fact that roads and lookouts were in attractive terrain, but five of the day users criticized a road closure and one respondent thought the roads should have higher retaining walls. Backpackers, on the other hand, took no photos of lookouts, and only one road photograph that criticized how close the road had been built to a river. The second most popular of the management features for backpackers were backcountry campsites (n=12); buildings were second for day users (n=12). No day users photographed campsites and only one backpacker photographed a building.

Mirroring the importance ratings, backpackers did not appreciate management features that intrude on wilderness, but they did like "primitive" trails, and backcountry campgrounds. In almost perfect counterpoint to the backpackers, day users liked improved trails, paved roads and lookouts, various buildings, and any other feature that helped them view large areas of the park easily and in physical comfort.

Wildlife

Virtually all of the wildlife photographs from both groups were positive (fig. 3), but the backpackers shot far fewer photographs of animals. Although both rated wildlife as an important feature of their visit to the park, day users took a total of 115 wildlife photographs while backpackers took 36. The day user average was 2.34 wildlife photos, more than twice as many as the backpacker average of 0.878 (F=21.904, p=0.00001). This suggests that day users had an easier time getting close enough to animals for a photo opportunity, that they were photographing more animals that were accustomed to humans and cameras than backpackers were, and that the relative tameness of the animals did not bother them. Although backpackers spent much of their time away from the park's crowded

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developed areas, they would have had some easy animal photo opportunities when they went to pick up backcountry permits, or on their way to and from trailheads. The data indicate that viewing animals that are accustomed to crowds of humans was not an important part of the backpackers' experience.

Both groups photographed animals that are partially habituated to humans (fig. 3, page 19). Throughout Rocky Mountain National Park visitors commonly encounter animals that do not flee when they see people, and some animals beg for food. Backpackers shot wildlife photographs from trails and designated backcountry campgrounds; animals that spend time near these areas must be somewhat accustomed to people. However, the day users shot all of their wildlife photographs out of car windows, alongside roads, at lookouts, picnic grounds, or along popular day-hike trails where hundreds or thousands of people per day may easily visit during the summer and fall. Wildlife habituation is probably worse in these locations, and 34 day-user photos actually featured animals sitting in or standing on structures such as lookout railings. Nevertheless, habituated behavior did not detract from most day users' satisfaction that they were seeing animals in what they considered to be a relatively natural habitat.

On 17 photographs, day users commented about the friendliness of the animals. Examples include: "the animals have little fear; they watch us as we watch them;" "it's nice to see wildlife so close by;" "[I am] impressed by [chipmunks'] friendliness and seeming to be so tame;" "we had been hearing about this friendly deer from other hikers on their way down;" "[the deer] is so calm and unafraid. She posed for us, looking right at the camera." An additional seven day users shot positive photographs of people feeding animals and one noted that the "squirrel actually came to get the peanuts from the kids' hand." We recorded five negative comments based on photographs of people feeding animals.

Human impacts on the environment

Backpackers put considerable physical effort into hiking away from the developed "frontcountry." Unless day users hiked vigorously to escape the frontcountry during their brief visits, they presumably spent most of their time within sight and sound of people, paved roads, buildings, or popular trails. Backpackers, however, took more human impact photos (backpackers n=28, day users n=16), and the mean number of impact photos per person was twice as high for backpackers (0.683) as for day users (0.327) ($F=5.084$, $p=0.027$). This suggests that day users are somewhat desensitized to impacts such as litter and horse manure, and accept these conditions as part of their experience in a wilderness park more readily than do backpackers. Backpackers took more photos, on average, of all the human impact categories except for trail impacts.

In almost perfect counterpoint to the backpackers, day users liked improved trails, paved roads and lookouts, various buildings, and any other feature that helped them view large areas of the park easily and in physical comfort

Negative and positive photographs

Over all the photographic categories, day users took a total of 525 positive photos and 28 negative; the backpacker total was 411 positive and 38 negative photos. Backpackers took 60% more negative photographs per person (mean=0.927) than the day users (mean=0.571), indicating that backpackers had a greater number of negative impressions of the park.

Conclusion

We had first hypothesized that backpackers would have a greater desire for pristine nature and solitude than day users would and this hypothesis is supported by some of the results. Although day users and backpackers both indicated that they came to Rocky Mountain National Park to enjoy the natural environment, they had different strategies for doing so that required different, sometimes opposing, park management practices. Backpackers did not appreciate management features that make the park easily accessible (such as paved roads and buildings), while day users did. Even though backpackers felt that wildlife, in general, was an important part of their visit, they did not think that human-habituated, roadside wildlife was important enough to their experience to photograph in large numbers. Backpackers also disliked human impacts on the environment much more than day users did, although day users generally spent more time in impacted areas. These results suggest that the backpackers placed a high priority on getting away from other people and the impacts that people have on wilderness and wildlife.

We also hypothesized that backpackers, because of their higher expectations, would have more negative impressions during their visits to the park than day users would. This was true, although both groups who took part in this study were largely pleased with the park and took many more photographs of important, positive experiences than negative experiences. Mountain vistas and water were the most popular photography subjects, not human impacts or negative management features (Taylor et. al 1995a, b). Visitors appreciate Rocky Mountain National Park, but people who visit casually and briefly, spending much of their time driving or taking short dayhikes, may enjoy their visit more than people who care intensely about having an active, wilderness experience. PS

Sarah Flick, at the time of the study, was a Social Science Researcher with Johnson Controls World Services in Fort Collins, Colorado. Dr. Jontahan Taylor is a Research Social Scientist with the Midcontinent Ecological Science Center, USGS Biological Resources Division, in Fort Collins. He can be reached at 970-226-9438; e-mail: jonthan_taylor@usgs.fov.

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Paleoclimate during the Redwall karst event, Grand Canyon National Park

By Ray Kenny

Figure 1 (right). The Redwall Formation (top shown by arrow) holds many clues to the ancient climate in what is today Grand Canyon National Park, Arizona. The research focused on chemically resistant deposits, rather than fossils, within the limestone layer to provide insight into the terrestrial climate about 325 million years ago.

Grand Canyon National Park (fig. 1) has always been known as a Geologist's paradise (Kenny 1993). The rock formations exposed in Grand Canyon (fig. 2) range in age from the 1.7-billion-year-old Vishnu schist of the Precambrian Era (exposed in the Inner Gorge of the Grand Canyon), to the 250-million-year-old Kaibab limestone of the Paleozoic Era (exposed along the north and south canyon rims). Exposed upstream of the park in the northernmost portion of Marble Canyon is the lower part of the younger, 195-210-million-year-old Chinle Formation (late Triassic Period). At the western end of the park, 1.16-1.25-million-year-old (Late Cenozoic Era) basaltic lava flows are also prominently exposed (Hamblin 1994). Both the age and variety of rock formations, in addition to the excellent exposure of these rock formations, make Grand Canyon a spectacular area for geological research.

At first, it might seem that much of the geological research has already been accomplished at the park, but the application of new technology and instrumentation has resulted in new geologic insight. Indeed, ongoing field research has also added to the baseline geologic information about Grand Canyon (Beus 1989; Bloeser 1985). This study has combined both fieldwork and new technology and has focused on the Redwall Formation (Mississippian Period).

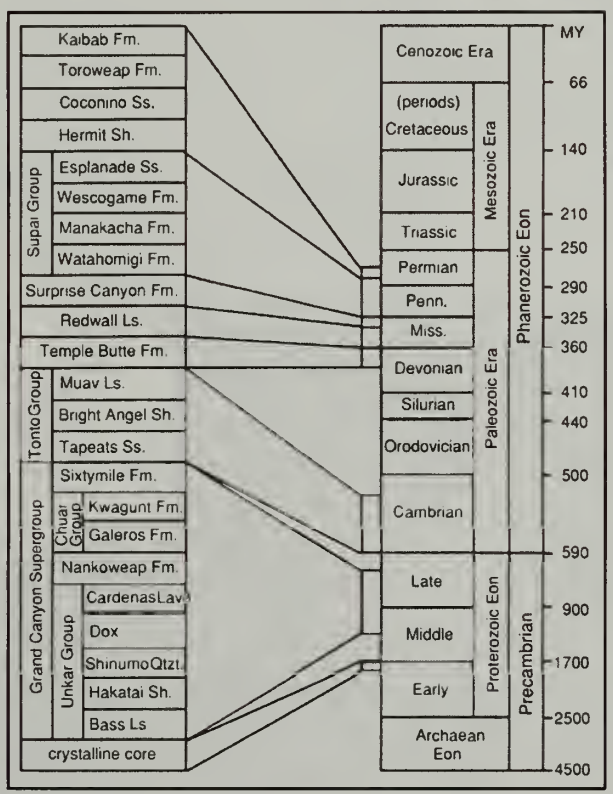

Figure 2 (left). Stratigraphic column of the major rock formations in Grand Canyon compared to the geologic timetable (after Haq and Van Eysinger 1987; in Beus and Morales 1990). The abbreviation "MY" refers to millions of years before present.

The Redwall Formation

The Redwall Formation has been the subject of numerous and diverse geological and paleoecological studies. The Redwall was deposited in a warm shallow sea about 330 million years ago and has many well-preserved fossils. It consists primarily of light-colored, blue-gray limestone and chert[1] lenses with minor dolomite. However, much of the formation has been stained red by iron oxide weathered out from the shale of the overlying Supai Formation. The ubiquitous red surface "stain" is the reason for the name "Redwall." The fossil record, extracted from previous studies of the Redwall Formation, is both extensive and well-preserved, and has yielded much qualitative information about the paleoenvironment of the ancient shallow sea (e.g., McKee and Gutschick 1969).

Scientists have derived information about the Redwall through the identification and study of foraminifera, crinoid, coral, cephalopod, brachiopod, and other fossils from this formation. Additionally, scientists have also been interested in the formation because its upper member, the Horseshoe Mesa Member, was exposed to the atmosphere

[1]A hard, dense, fine-grained rock made up of silicon and oxygen. Flint is a dark-colored variety of chert.

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Paleoclimate continued from page 21

for an extended period of time (approximately 325 million years ago) before the deposition of the overlying Supai Formation sediment. During the time the Redwall Formation was exposed to the atmosphere (subaerially exposed), the limestone was severely altered by chemical dissolution and reprecipitation and developed a recognizable karst (limestone) topography replete with caves, caverns, sinkholes, chert-lag breccias, red-residual soil, and related solution features. Detailed and ongoing research on karst features (Kenny 1989) has produced new insights into information about the ancient terrestrial climate (Kenny in press).

New karst features

During the Redwall karst event, chemical dissolution of the chert-rich limestone produced numerous large- and small-scale features. In many areas of northern Arizona (outside and south of Grand Canyon National Park), much of the limestone was completely dissolved away, leaving behind a heap of more chemically resistant, partially weathered, and cemented chert breccias or "lag" deposits. In some areas, these residual chert-lag deposits are quite extensively developed (fig. 3). In other areas, such as in the park study area, the residual deposits are not as well developed. In all cases, the chert-lag deposits are held together by silica (quartz) "cement," and locally contain preserved soil features. These residual deposits were cemented together by silica that formed at or near the time of the Redwall karst event, at or near the Earth's surface.

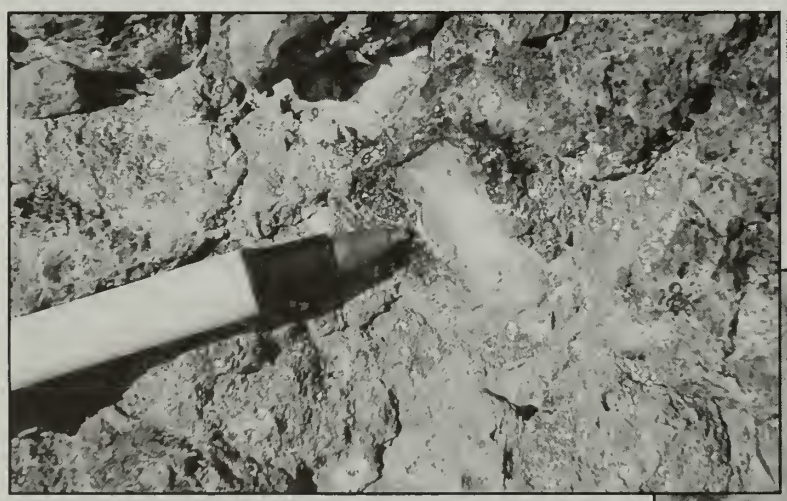
The cement that holds together the residual heaps of partially weathered chert, also called secondary silica (Kenny and Knauth 1992), formed under very different environmental conditions than the chert. The chert formed under marine conditions at approximately the same time as the limestone was forming. The secondary silica cement formed under terrestrial conditions much later than the already solidified chert. The secondary silica cement also has forms and features that are distinct from the chert, owing, in part, to its formation under very different environmental conditions. Figure 4 illustrates some of these unique forms of silica. Both macroscopic and microscopic studies reveal the presence of microlaminated, fibrous, botryoidal (like bunches of grapes), and other forms of silica cement. These distinctive forms of silica may have formed under subaerial, terrestrial conditions (as shown by Kenny and Knauth 1992). In addition, the secondary silica cement is also chemically distinct. It is the chemical distinction that has been used to provide insight into the ancient terrestrial climate, about 325 million years ago.

By studying the rocks and minerals, geologists have shown that global climate change is a natural phenomenon that has occurred countless times in the geologic past

The ancient climate

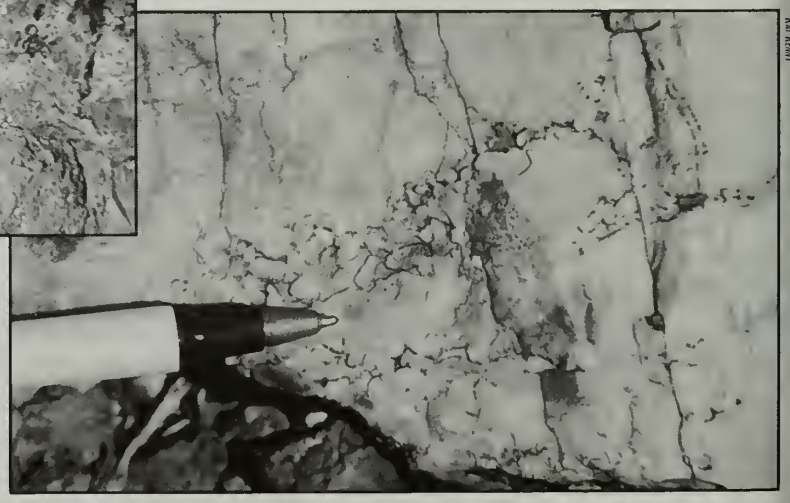
Samples of the secondary silica cement were chemically analyzed for oxygen and hydrogen isotopic values. Each element that makes up the basic chemistry of the silica has its own distinct isotopic value. These values will remain relatively unaltered in silica until the mineral is either destroyed by weathering or altered by relatively high temperature and pressure. Since the secondary silica cement was formed (or precipitated) in the presence of fresh water (on land), it is chemically (isotopically) distinct from the chert (also quartz) that actually precipitated in the presence of seawater. This isotopic difference, dictated by the environment in which the mineral formed, can be clearly and unambiguously determined. The isotopic value for the silica cement can then be used to determine the temperature at which the substance formed because the isotopic value is also determined, in part, by the temperature at the time of precipitation (see Knauth and Epstein 1976; Kenny and Knauth 1992).

Using this information, we determined that the near-surface temperature at which the cement formed was a balmy 27-28°C (81-82°F). These preliminary temperature estimates are geologically reasonable values and are in agreement with the range of temperature or climate needed to produce



RAY KENNY

Figure 3A (above). Secondary silica deposit at the top of the Redwall Formation (Bass Canyon). The chemistry of the secondary silica was used to determine the ancient terrestrial temperature range.



RAY KENNY

Figure 3B (right). A chert-lag deposit at the top of the Redwall Formation (Bass Canyon). Chert is more chemically resistant to erosion and dissolution than the limestone matrix and is considered evidence for surficial weathering.

an extensive karst event. The paleotemperature estimates are probably a long-term climatic average. The paleotemperature estimates are significant because, until recently, quantifying terrestrial paleoclimate conditions has been extremely difficult, if not impossible.

Benefits of climate research

Modern global climate change is very much on the minds of resource managers, scientists, and the public. By studying the rocks and minerals, geologists have shown that global climate change is a natural phenomenon that has occurred countless times in the geologic past. To understand modern climate change and associated resource concerns, we first need to quantify the conditions and features of ancient, naturally occurring climate shifts. The research at Grand Canyon will provide scientists and resource managers with new information about ancient climate changes. Information from this research can be used in a management and education program designed to inform the public about ancient climates (which were very different from our modern climate) and address public questions about modern global climate change. Resource managers may also find the research useful in terms of describing the importance of the preservation of biological and geological resources–resources that may hold the key to a vast amount of information that has yet to be tapped and used by our modern society.

Finally, the research at Grand Canyon can be used at other national parks and monuments (e.g., Death Valley and Glacier National Parks) to quantify past climate and climate change. But more work remains at Grand Canyon! The 250-million-year-old Kaibab Limestone (the rock formation that makes up the rim of the Grand Canyon) has also been subaerially exposed and karsted. The Kaibab limestone may also provide us with information about ancient climate change from yet another interval of time. In the meantime, the research at Grand Canyon is providing us with greater insight into the climate of the geologic past–a climate that helped produce the stunning array of rocks exposed in Grand Canyon National Park. PS

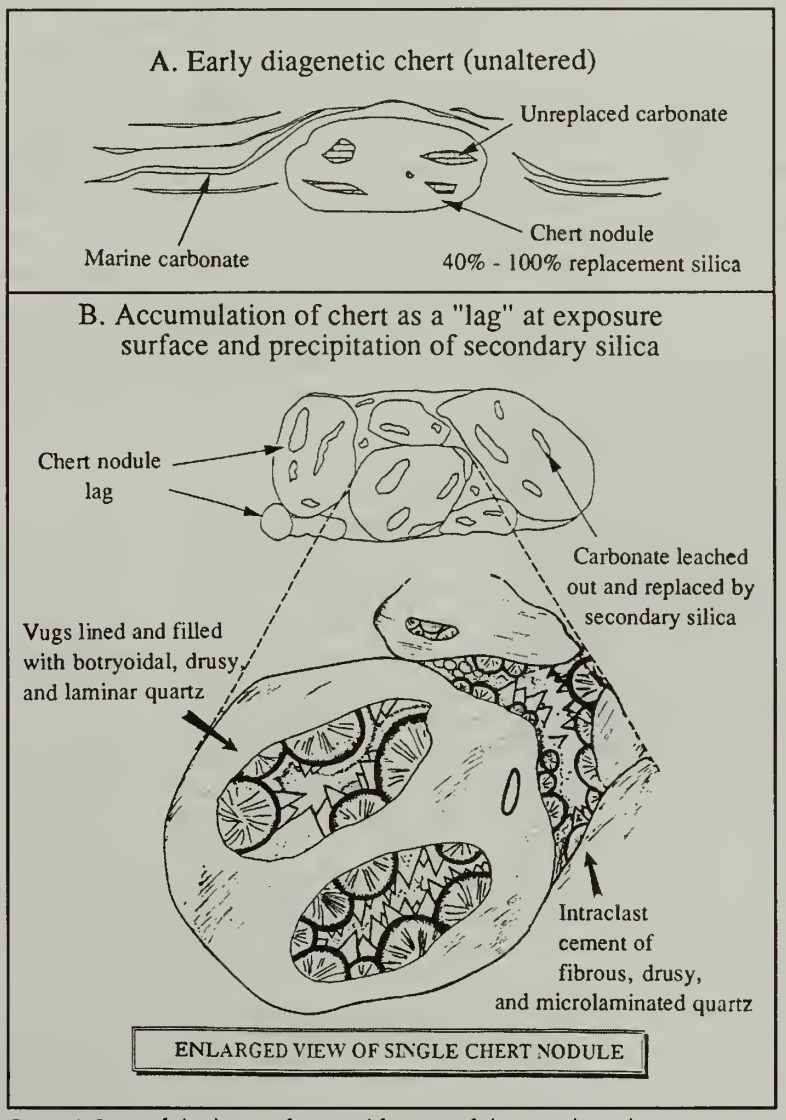


Figure 4. Some of the distinct forms and features of the secondary silica cement that precipitated during the Redwall karst event approximately 325 million years ago: (A, above) early marine chert; and (B, below) examples of secondary silica.

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The Big Cypress hydrology program

A proactive approach to establishing effective multiagency partnerships

By Don P. Weeks and Christine J. Bates

When asked to identify the national park units in south Florida, many people begin and end with Everglades National Park. A lesser known park unit, which shares a common boundary with Everglades, is Big Cypress National Preserve. At 295,026 ha (729,000 acres) in size, Big Cypress is the 12th largest unit in the national park system in the continental United States. Established in 1974, the preserve is located in southwest Florida within the Big Cypress Swamp physiographic province (fig. 1). This region extends westward from the Everglades to near the west coast of Florida, and southward from the Caloosahatchee River drainage to the estuaries of the Gulf of Mexico.

The physiographic setting

Water is the basic component of the ecosystems within the Big Cypress Swamp. This water-dependent ecology is a result of the subtropical climate and physiographic setting: the climate provides the hydrologic input; the physiographic setting controls the distribution of that input. The natural topography in the preserve is flat, ranging from near mean sea level (msl) in the south to 5.8 m (19 ft) msl in the northeast. Topographic slopes in the area average less than 9 cm/km (0.5 ft/mile). The preserve has two distinct climatic seasons; a wet season (May-October) and a dry season (November-April) (fig. 2). The annual mean precipitation in the preserve is 143 cm (56.3 in), of which about 75 percent normally falls during the six-month wet season. During this time, as much as 90 percent of the preserve is inundated to depths ranging from a few centimeters to more than one meter. As the dry season begins, generally in October, water levels start to recede. The recession continues until May, when approximately 10 percent of the preserve is covered by water in ponds and sloughs. In this predominantly wetlands habitat, the seasonal inundation of land and depth of inundation are critical for maintaining this delicate ecosystem.

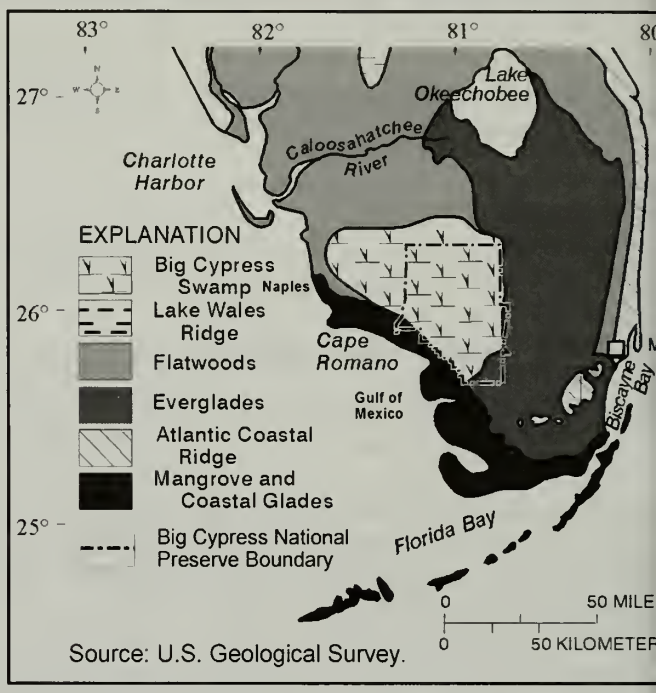


Figure 1. Big Cypress National Preserve lies within the Big Cypress Swam physiographic region, a large water-dependent ecosystem. Century-long modifications to this delicate system have altered the natural ecology, w the preserve is addressing through its hydrology program.

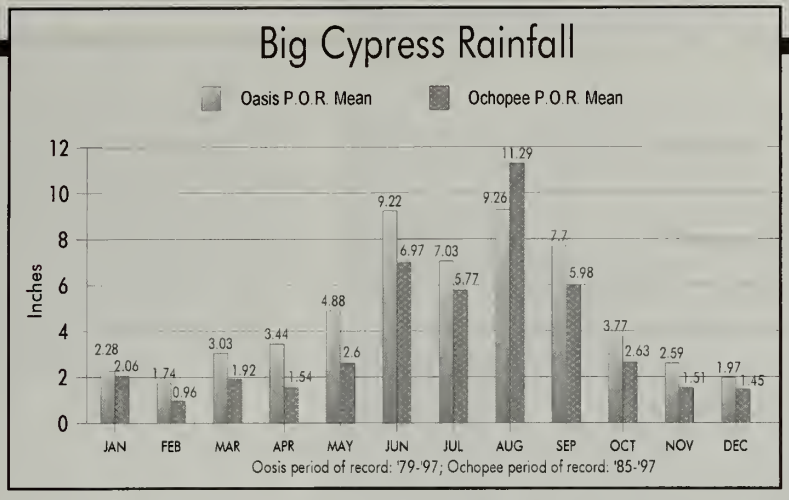
Water resources management plan

Although the importance of water in the preserve has long been recognized, only limited efforts have been made in the past to document and understand its hydrologic significance. With limited human resources and budget, the preserve had been forced to play a reactive role in the internal and regional water-related issues. Recognizing this as a problem and in response to the increasing multiagency efforts to restore the south Florida ecosystem in the 1990s, the preserve added permanent technical staff and increased funding for the hydrology program. This paved the way for a cooperative effort between the preserve and the NPS Water Resources Division to prepare a Water Resources Management Plan (WRMP) for the preserve. This plan, completed in 1996, provides a review of the current legislation, existing hydrological information, an in-depth analysis of water resources issues, and the development of an action plan (30 project statements) to address both internal and external water-related problems. During the development of the plan, the preserve sought input from the various federal, state, and county agencies, and American Indian tribes to reinforce the cooperative focus of the National Park Service. The WRMP is proving to be an excellent management tool in the dynamic hydrological and political environment of south Florida.

Hydrology Program and accomplishments

The preserve's technical staff recognizes the importance of improving the quality, consistency, and efficiency of hydrological data collection to meet the increasing internal and regional management needs. Since cost was the limiting internal factor, the preserve looked outside the Park Service for long-term cooperative support. The hydrological information was not only important to the preserve, but also important to other federal, state, and county agencies in south Florida. The South Florida Water Management District (SFWMD), a state agency, provided this support. A five-year cooperative agreement was executed between the SFWMD and Big Cypress National Preserve in 1995 to combine

The decision to create a technical water resources staff and prepar water resources management plan helped the preserve define its wa resource objectives and forge strong local partnerships



2. The preserve cterized by a ath dry season winter, followed nmer wet season 5 percent of the precipitation During the wet as much as 90 of the preserve lated.

resources to support and improve the preserve's water stage and water quality monitoring program. Since 1995, the SFWMD has contributed over $130,000 in field equipment upgrades, water quality analyses, quality assurance/quality control (QA/QC) inspections, data processing, staff support, and training. Under this agreement, the preserve collects continuous water stage data and monthly water quality samples following a strict quality assurance project plan approved by the SFWMD. This hydrological information is stored on the SFWMD regional databases, making the data available to all interested groups.

Given the intent of the WRMP to define the preserve's water resources objectives and the strong support from the SFWMD, the preserve has become more active in the regional scientific efforts. In 1996, under the authority contained in Section 528 of the 1996 Water Resources Development Act, nominations for critical restoration projects in south Florida were solicited. The nomination and prioritization of the critical restoration projects were based on these criteria:

1. the project produces independent, immediate, and substantial restoration, preservation and protection benefits;
2. the project can be initiated prior to September 30, 1999;
3. it is consistent with components of the integrated plan to restore, maintain, and protect the ecosystem, developed by the Florida Governor's Commission for a Sustainable South Florida;
4. the total project cost estimate is less than $50 million; and
5. a cost sharing partner has been identified.

The preserve has submitted a proposal for consideration as a critical restoration project that addresses a significant hydrological problem identified in the WRMP. The proposal would help to restore a more natural hydropattern to southwest Florida, including the preserve, by improving the conveyance of surface water through U.S. Highway 41 (Tamiami Trail; fig. 3). The Tamiami Trail, constructed in the 1920s, is a two-lane highway that bisects the preserve and connects Miami to Naples. This elevated roadbed impedes the natural north-south "sheetflow[1]" in the region. The existing bridges and water control structures are inadequate for distributing this sheetflow beneath the Tamiami Trail. This results in the interruption of natural seasonal hydropatterns (quantity, timing, and distribution of surface water flows) for the area.

Over 90 project proposals were submitted and reviewed by the South Florida Ecosystem Restoration Task Force[2], U.S. Army Corps of Engineers, and Florida's Governor's Commission. After several meetings to prioritize the numerous candidates, the $15 million proposal submitted by the preserve was ranked second, and was one of five proposals presented in Washington, D.C., as an example critical restoration project proposal. The preserve has since taken the lead to identify a project management team consisting of representatives from the U.S. Army Corps of Engineers, Florida Department of Transportation, SFWMD, Florida Department of Environmental Protection, and the National Park Service. The Environmental Research Institute of Michigan is currently involved in an EPA-funded project that is evaluating the utility of synthetic aperture radar (SAR) collected by the ERS-1 satellite for monitoring wetland vegetation communities in southwest Florida. This information, currently being reviewed by the project management team, may assist with the project design by identifying appropriate locations for additional water conveyance structures within the 70 km (43.6 mi) project area of the Tamiami Trail.

Big Cypress National Preserve, Christine Bates

Figure 3. Built in the 1920s, the two-lane Tamiami Trail interrupts the natural north-south flow of water through Big Cypress National Preserve and Everglades National Park. Improving the conveyance of sheetflow through the highway is a critical aspect of ecological restoration in the preserve.

The preserve's technical staff has also taken a lead role in a multiagency effort to produce a comprehensive science plan for southwest Florida. At the request of Interior Secretary Bruce Babbitt and the South Florida Ecosystem Restoration Task Force, a science workshop steering committee has been established to initiate the effort. A multiagency effort is currently underway to develop this regional science plan for the Big Cypress Basin. Comprised of public land managers, regional planners, researchers and agricultural landowners, the steering committee's efforts focus on the Big

continued in right column on page 27

[1]A broad expanse of moving water that spreads as a thin, continuous film over a large area, and is not concentrated into well-defined channels.

[2]A federal-state partnership, established in 1993, that is working to coordinate the development of consistent policies, strategies, plans, programs, and priorities for addressing the environmental concerns of the south Florida ecosystem.

CECIL SCHWALBE

Figure 1. One of the rarest and oddest frogs in the Southwest, the barking frog was confirmed on Coronado National Memorial (Arizona) in 1993. This discovery, apparently of a thriving population, provided an unexpected opportunity to study this reclusive species, whose natural history is almost totally unknown.

Ground-truthing a troll

Studying the barking frog at Coronado National Memorial

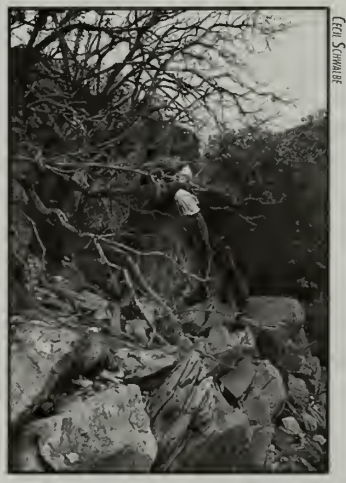
By Cecil Schwalbe and Barbara Alberti

Like the subterranean beings in Scandinavian mythology that lurked underground for unwary prey, the barking frog *(Eleutherodactylus augusti* [fig. 1]) often waits under rocks or in holes and crevices for dinner to wander by, a dinner of invertebrates, not goats or humans. One of the rarest, and oddest, frogs in the Southwest, the barking frog is known in the United States only from isolated localities in southern Arizona, southeastern New Mexico, and west Texas. It ranges south in Mexico to the Isthmus of Tehuantepec, but nowhere is it considered abundant.

Until 1993, when an apparently thriving population of barking frogs was confirmed on Coronado National Memorial, the barking frog was known in Arizona only from a handful of individual frogs collected from four isolated mountain ranges. This discovery provided an unexpected opportunity to study this reclusive species, whose natural history is almost totally unknown. Biologists from the Cooperative Park Studies Unit at the University of Arizona (Tucson) and Coronado National Memorial are coordinating a study of this population with other university and agency scientists.

A member of the large tropical frog family Leptodactylidae, the barking frog is the only anuran in Arizona and New Mexico to undergo direct development; that is, females lay 20–80 eggs not in pools of water but in wet spots under rocks and in crevices, where barking frogs go through the tadpole stage in the egg, hatching into small frogs about a month later. The males supposedly tend the underground nest, guarding the eggs from small predators and hydrating the eggs by urinating on them.

Barking frogs are named for the explosive breeding call of the males, like the bark of a dog when heard at a distance, but a more guttural "whurr" at close range. At Coronado National Memorial, the call is less doglike, often sounding like the croak of a raven. We believe some barking frog populations may have been overlooked in Arizona because casual listeners may have thought calling barking frogs were Couch's spadefoot toads *(Scaphiopus couchi)*. At Coronado, most male barking frogs call from small chambers or crevices. They sometimes respond to other calling males and vocalize while active on the surface. At Coronado, barking frogs are associated closely with limestone outcrops (fig. 2). In other areas, they may be found on rocks other than limestone, and in southeastern New Mexico they may occur in extensive rodent burrows in barren creosotebush flats.



CECIL SCHWALBE

Figure 2. Habitat for the barking frog at Coronado is a surprisingly rugged limestone outcrop, replete with boulders and crevices.

In Arizona, breeding of barking frogs is tied closely to onset of the summer rainy season. There is

The barking frog is named for the explosive breeding call of the mal like the bark of a dog when heard at a distance. However, at Coronado, the call sounds more like the croak of a raven

CECIL SCHWALBE

Figure 3 (above). Radiotronmitters belted oround the woists of four study frogs helped reseorchers onswer some bosic questions obout the life history of the reclusive onimol. For exomple, home ronge wos limited to the limestone outcrop where the frogs were originolly coptured, togged, ond releosed.

frenzied calling, apparently by most of the adult males in the population, during and following the first heavy (>1 cm; >0.4 in) rain, with fewer and fewer males calling during subsequent showers. We have not been fortunate enough to observe breeding by barking frogs at Coronado yet, but we did capture (and release) a single hatchling frog in 1996.

With funds provided by the National Park Service and Southwest Parks and Monuments Association and with the assistance of more than 30 volunteers, we captured, marked, and released 13 barking frogs on a single limestone outcrop in the memorial in 1996. Frogs were active from the first summer rain on June 30 until early September. Captured frogs ranged in size from the 0.83-g (0.03-oz), 21-mm-long (0.83-in [snout-to-vent length]) hatchling to a 55-g (1.93-oz), 85-mm (3.35 in) adult female. Using radiotelemetry (fig. 3), we followed four frogs for up to a month. Frogs roamed over much of the approximately 100 x 100-m limestone hill, but did not cross over to adjacent outcrops. Although often choosing to walk or climb, barking frogs are prodigious jumpers (fig. 4). Even while carrying a radiotransmitter belted around the waist, barking frogs easily made leaps of 70 cm (27.6 in) or more from boulder to boulder.

Based upon scat analysis and observations, barking frogs at Coronado feed on field crickets *(Gryllus* spp.*)*, silverfish *(Lepisma saccharina)*, centipedes *(Scolopendra* sp.*)*, scorpions *(Vaejovis* sp.*)*, and kissing bugs *(Triatoma* spp.*)*. At other localities, they have been reported to eat cave crickets *(Ceuthophilus* spp.*)* and land snails *(Bulimulus* and *Succinea)*.

Figure 4 (below). To help them negotiote the rough terroin of their rocky home, borking frogs feoture tough "Vibrom" soles on their feet.

CECIL SCHWALBE

On the night following the first significant summer rainfall in 1997, we used over 30 volunteers to capture 15 barking frogs on several limestone outcrops on the memorial. We caught six frogs on our primary study site of the previous year, all recaptures, indicating that we have most of that subpopulation marked. Using PIT-tags (passive integrated transponders), we now have marked 22 frogs at five sites at Coronado. This summer we plan to bring a graduate student onto the project to further study the ecology of this interesting frog, to estimate population sizes using mark-recapture, to evaluate various monitoring methodologies, and to begin assessing metapopulation dynamics.

From our preliminary data and the scanty life history known of the species, we believe the barking frog has very low population densities and is long-lived. These characteristics make barking frog populations vulnerable to overcollecting; it is fortunate that the population at Coronado occurs on Park Service lands, where collecting is forbidden. This protected population will provide important information on the life history of this unusual species and perhaps allow us to test metapopulation models applicable to anuran conservation and management. PS

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Big Cypress continued from page 25

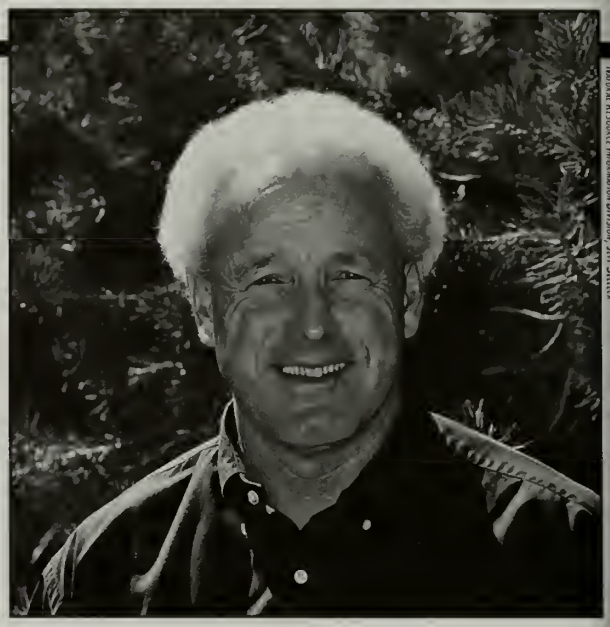
Cypress Basin with the goal of accomplishing three tasks: (1) conduct an issues characterization workshop, targeting the scientific community in the Big Cypress Basin to identify, characterize, and prioritize the natural resource issues within the Big Cypress Basin; (2) conduct an inventory of existing research and monitoring information within the Big Cypress Basin; and (3) conduct a second workshop to link priority natural resource issues and science information needs for the development of a Big Cypress Basin science plan.

The issues characterization workshop was conducted in 1997 and was attended by over 70 regional scientists. During this workshop, the participants identified, characterized, and prioritized natural resource issues within the Big Cypress Basin. In March 1998, three workshops were held to prioritize natural resource issues in the Big Cypress Basin, and currently the initial draft of the science plan is being written. Also, the inventory database of monitoring and research projects was completed this year and can be reviewed on the Internet at *http://library.fgcu.edu/big_cypress.*

Big Cypress National Preserve is beginning to produce successful results for defining, monitoring and managing its water-dominated ecosystem. The approach has been aggressive and the recent results have been rewarding. In the future, the preserve's ability to continuously seek improvement for evaluating and managing its hydrological system will be the key for meeting the dynamic resource management needs within its boundary and south Florida. PS

Don Weeks was formerly a Hydrologist at Big Cypress National Preserve; he is now a Hydrologist with the NPS Water Resources Division in Lakewood, Colorado. He can be reached at 303-987-6640; e-mail: don_weeks@nps.gov. *Christine Bates is a Hydrological Technician at the preserve; 941-695-2000, x345;* christine_bates@nps.gov.

An interview with Superintendent Alan O'Neill



Alan O'Neill, Superintendent of Lake Mead National Recreation Area.

By the editor

In eleven years as Superintendent of Lake Mead National Recreation Area (Nevada and Arizona), Alan O'Neill has helped build one of the leading resource management programs in the Pacific-West Region. A brilliant manager with a human style, O'Neill listens, offers support, and invites participation, building trust with his staff and park partners. In recent years his leadership skills have landed him collateral assignments as the chair of the Pacific-West Region's resource management taskforce and as a partner in the initial planning phases of the California Desert Ecosystem Management Initiative, a complex interagency framework for managing over 25 million acres of public land. Twice during the last fifteen months, our featured guest talked with me about the remarkable transformations in the resource management program at Lake Mead, the benefits of collaboration, and the importance of managing a desert park in its ecological context.

Q: What role did strategic planning play in building your resource management program?

A: When I came to Lake Mead in 1987, I found that this park was driven by operations. About a quarter of all the visitor protection incidents for the National Park Service come out of this park. I looked at that and said, I'm going to learn about that. But we need to think strategically. We have to know where we want to take this ship. I'd ask our people what business they thought we were in and I could never get any consistency. That made quite an imprint on me. So, one of the first things we needed to do was to develop a strategic plan.

Q: To accomplish what?

A: We needed to interpret what it meant to be a recreation area. We had bought into the perception that we were just a law enforcement park, and the local people thought of this as their local recreation area. We needed to define our desired future conditions so we could build a path to get there. I said, we *can* define what we're all about. We have an obligation and a duty to define what we're all about. I said, this is a serious exercise, and whatever we decide on *collectively* is what we'll put our efforts toward.

Q: How did resource management come to the forefront?

A: Bill Burke, the park's first resource manager, had labored for years trying to bring respect to the resource. He kept trying to make improvements, but he was a lone voice in the wilderness. When we went through the strategic plan it all came out that we had an incredible resource. Some of our people had not appreciated this. Until we embraced the resource, and could feel it, see it, and understand it, how in the world were we going to dedicate ourselves to the tough task ahead of protecting it? So, this was one of the first things we focused on.

Q: Did the staff just naturally buy in to this?

A: We had to do a lot of work internally first. We wanted the entire staff to understand the resource and have a chance to experience it. We did this through a series of three-day campouts where we would discuss the work that we're all about, the resource that we had, and build that commitment and dedication to protecting the resource. Once we had educated ourselves, then we were prepared to go out and build partnerships and community support.

Q: Any revelations from that experience?

A: Eighty-seven percent of the park's million-and-a-half acres is land on which we had done very little resource management. We had acquiesced our responsibilities to other agencies like the state fish and game organizations. The Bureau of Land Management was in charge of burro management and grazing. We were so dependent upon other agencies doing our job for us that we had lost control of what was happening to our resource, and that was unacceptable.

Q: Did the public support this new orientation?

A: Yeah, but we had a massive job to do, because all the politicians, the users, and the local communities related to Lake Mead as a water recreation park. We wanted to wrest back some control over the land resources. So, we started a leadership program to train our people to work interdependently. We brought in scientists to help us think through what the desired future conditions should be. When we knew what the end in mind was, we brought in anybody who would listen to us.

Q: When did you see a change?

A: Once we got the attention of our senior senator, Senator Reid, who was on the appropriations committee, then we started hitting pay dirt. The politicians all of a sudden had a different view of Lake Mead. When we brought them out and educated them, they wanted to see the land resource protected also. And so we started working with them and building base increases.

Q: Were any particular resource issues important in the education process?
A: Tamarisk choking our springs and in the beach areas; the impacts from feral burros; the impacts of grazing. We flew the senator over and showed him how some of our systems were absolutely devastated, that the only community we had left was the creosotebush community. That's how far we had come from not caring properly for this resource. We had to show it on the ground. We had to get them to feel it.

Q: What effect did this have on your program?
A: We have gone from two professionals in 1987 and a $120,000 resource management budget to 13 permanent, 15 FTEs total, and a $1.1 million operating base in 1998. In addition, we have about $500,000 in soft money. That's money we leverage through all kinds of interesting partnerships. It's money we get from grants. It's money we get from Clark County habitat conservation. Most of it requires hard work to keep attracting. We use our base money to make sure the most critical things get done and supplement it with these funds.

Q: Staffing must have been on your mind?
A: We were starting from such a low level that we could offer people a real chance to make a tremendous difference to the resource. Other parks can't always offer that. We had a clear priority staffing strategy and we wanted to get the best people. We went out and recruited who we thought had the interest, commitment, and talent to do the job. In return for that we were going to give them a tremendous amount of professional development. They would have an opportunity to develop a program, implement it, and provide leadership for it.

Q: Kent Turner has obviously been very successful as your Chief of Resource Management.
A: Kent is one of the most effective administrators I've ever worked with anywhere in my federal career. He's not a show horse, he's a work horse. That's what it has taken to build this program. He took the responsibility of making sure we stayed on our strategic course. He kept making improvements and hiring good people, setting up the structure, and getting the money. As a result, our resources are better understood, valued, and supported by the park and local, regional, state, and federal partners.

Q: Was there any resistance to such rapid change?
A: When we started building a resource team some people saw that as taking away from their programs, because they had needs. Our rangers were overstressed, and our maintenance staff was shorthanded, so it was easy to take pot shots. We had to continually go back to the strategic plan that we had all agreed to.

Q: Were their concerns legitimate?
A: We didn't reshuffle park money. All the money for the resource program came as an addition to the park budget. It's true that if you don't get increases for maintenance and ranger activities your costs go up and your capabilities go down. There was some issue with that. But it's simply that the park had a duty by law to take care of the resource, and we had failed miserably in that duty. We had a large catch-up to do. Once we build this program up to where we have a suitable core then we can start adding to some of these other program areas, too.

Q: Have you reached that goal?
A: We think we have a sufficient core staff, so now we're building through partnerships and alternative funding sources. Kent is very, very good at using partnerships and alternative workforces that he can assemble at very little cost. Over the last couple of years, we have had lots of people out doing projects: AmeriCorps, work programs from the court system, SCAs, interns. There really is a way to leverage labor sources. Since we've built a solid core, we can be aggressive in going out to the outside community for private donations and grants that supplement our base program. That's where our emphasis is now.

Q: Is your success a model for other parks with similar needs?
A: We all hope that we can increase our base funding. But this is going to be tougher and tougher. The money in the future is going to come from collaborative initiatives and budget requests. It won't come as much from single agency proposals. The more agencies you can get as cooperators, the more collective agency support behind a proposal, the more chance it has in coming. It's to our advantage to collaborate. We're learning that from the California Desert Ecosystem Management Initiative.

Q: Speaking of which, how will this huge desert area with all these different agencies be managed?
A: We have a philosophy in regard to the California Desert that whether you're the Bureau of Land Management, the Fish and Wildlife Service, the U.S. Geological Survey, the Park Service, or the military, we have a grand experiment. We have collective responsibility for stewardship of the desert, and we all have our individual mandates. There's probably room in the California Desert for a diverse spectrum of recreational activity, but it doesn't necessarily have to take place within the park or even adjacent to it. Like biosphere reserves, we probably should have core areas that are lightly used, that serve as our most pure genetic reservoirs. And then we have managed zones in which we can advance the state of knowledge about mankind's relationship with the bioregion through experimental management and science. And there will probably be areas with concentrated activity, including recreational use.

Q: So Lake Mead really operates within the context of the desert ecosystem these days?
A: Absolutely. We knew we were not going to be able to protect our park unless we were able to be effective in collaborative ecosystem initiatives. We wanted to hire people who were committed to teamwork and collaboration, people who were inclined to work within larger ecosystems. This has served the park resource very well.

Q: Any examples?
A: We invested a fair amount of time working on the Black Mountain Ecological Plan, the Parachant Plan, the Clark County Tortoise Plan, and other plans for the management of areas adjacent to the park. What we got in return was compatible management on a large section of our boundary. About 70 percent of our boundary is now in protected status. We've got about 30 percent left with some tough issues to deal with. To me, that was the advantage of hiring people who think a little more broadly, a little more holistically.

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Safe, effective, and humane techniques for euthanizing wildlife in the field

By Michael Aprill

Resource managers across the national park system are occasionally faced with the need to destroy wildlife species for a number of reasons, such as protection of endangered species, protection of the public health, and population control of species.

When choosing euthanasia techniques as part of a resource management program, managers must select techniques that are humane for the species being euthanized, safe for personnel carrying out the procedure, not dangerous to park visitors or nontarget species, and appropriate for the location and feasible within personnel and budgetary constraints.

In selecting a euthanasia technique, the manager must first consider that the technique is efficient and humane for the target species (American Society of Mammalogists 1987). The universally accepted standards for these criteria are found in the "1993 Report of the American Veterinary Medicine Association (AVMA) Panel on Euthanasia" (American Veterinary Medical Association 1993). These techniques fall into three general categories: injection (barbiturates), carbon dioxide, and gunshot. Whichever of these techniques the manager selects must be species-specific and correctly performed by trained personnel to be safe and effective.

Euthanasia by the injection of barbiturates (e.g., sodium pentobarbital) is perhaps the most humane euthanasia technique, and it is suitable for most species, safe for personnel performing the procedure, and moderate in cost (Fakkema 1994; Grier and Clovin 1990; American Humane Association 1988). Barbiturates are one of the cheaper euthanasia agents. However, as a controlled substance, the use of barbiturates requires a permit from the Drug Enforcement Administration, secure storage, and veterinarian supervision. The animal must be restrained during administration (e.g., squeeze cage) and personnel performing the procedure must be skilled. Dosages must be correct for the species and the animals' weight. A park's maintenance staff may construct squeeze cages of their own design or by using designs found in the literature. If a veterinarian is not on staff, one may be available from a nearby humane society or a local vet may be willing to consult as a nonpaid volunteer.

Another effective, humane, safe, and inexpensive euthanizing technique is carbon dioxide (Erickson 1994). This technique works well for most animals; however, some species and neonates may have some increased tolerance to carbon dioxide. Because carbon dioxide is heavier than air, care must be taken to completely fill the chamber before exposing the animal to the gas. This is of special concern with tall or climbing animals. Carbon dioxide is low cost. Supplies include a carbon dioxide canister, carbon dioxide, appropriate plumbing, and a chamber that can be constructed by park personnel. The main disadvantage of this technique is that it may not be suitable for remote or inaccessible locations due to difficulties transporting heavy CO_2 canisters.

If done properly by trained personnel, gunshot may be used as a humane form of euthanasia. For each species, the shot must be fired at a specific site on the animal to assure rapid death (Australian Veterinary Association 1987; Longair et al. 1991). One danger of this technique is that a bullet may

Table 1. Humane euthanasia techniques*

Method	Advantages & Disadvantages	Cost
Injection (barbiturates)	Most preferred method of euthanasia Suitable for most species Safe for personnel performing procedure Requires DEA permit, secure storage, and veterinary supervision Requires squeeze cage, which may be easily constructed by park personnel	Moderate
Carbon Dioxide (CO2)	Works well for most species Some species and neonates may exhibit increased tolerance to CO_2 Special care must be taken with tall or climbing animals to completely fill the chamber before exposing the animal CO_2 chamber may be easily constructed by park personnel Safe for personnel performing the procedure May not be suitable for remote locations due to weight of CO_2 canisters	low
Gunshot	Firearm must be of appropriate caliber and impact for species and must be delivered to specific site on animal Requires skilled marksman Possible danger to shooter from ricochet Possible legal constraints in some parks	Moderate

*All methods can be humane and safe if administered by properly trained personnel

ricochet off the substrate or cage and injure the shooter or others. The shooter must also have adequate eye and hand protection due to the possible danger from blood-borne pathogens. Additionally, there may be legal reasons why a manager may not want to use firearms in a park.

Managers wishing to learn more about specific euthanasia techniques are encouraged to consult the resources cited in this article or attend a euthanasia seminar sponsored by an organization such as the American Humane Association. For a summary of humane euthanasia techniques see table 1. PS

Michael Aprill is a recent graduate of the University of Wisconsin–Stevens Point with a degree in biology. During 1994, he served as a Volunteer in the Parks (VIP) for the Division of Resource Management at Hawaii Volcanoes National Park.

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O'Neill interview continued from page 29

Q: How valuable is the resource management function to the park?
A: I don't know how we operated without it. I don't know how we were making the decisions we made without asking questions.

Q: Has a different decision-making process evolved?
A: We're learning it's the collaborative process that helps you. More effective solutions just naturally come out of the process of involving scientists and bringing together a broad group. We're learning a lot by grouping parks with similar problems, like the desert parks. Joshua Tree is going to learn something of value to us all, we learn, and we get together and discuss it. The more we share and collaborate, the more we advance the state of science and management.

Q: Any specific advances?
A: We've done a lot of work on how you restore desert systems, particularly those that have been overgrazed by burros, and springs that have been choked by invasive species. We have learned a lot about tamarisk removal through experimental management, trial and error. Finally, we've found some things that consistently work. We now have a multiregion tamarisk-busting crew going out under NRPP money and working in maybe 20 different parks: Zion, Petrified Forest, Capitol Reef. It's more efficient to have a crew go out and help parks than to duplicate that function in each park.

Q: Helping other parks seems to come naturally to Lake Mead. Why?
A: Everyone's got more work that they can be doing. But nothing would get done if we didn't help each other. Let's not forget that we are part of one Park Service. At Lake Mead, we spend between 15 and 18 percent of our budget in support of collaborative park efforts in our cluster and region. The restructured National Park Service follows a shared leadership/shared resources paradigm. Regardless of how busy we are in our own parks, if this paradigm is going to work, we've got to share our resources. A superintendent has got to support that.

Q: What about helping parks with less obvious needs?
A: The Pacific-West Region has a resource task force that is providing some leadership in this area. We have developed a strategic plan for the region that will guide our resource stewardship activities over the next five years. We want to be able to provide the best service to smaller parks that don't have a resource specialist. Is it through a "circuit rider" system made up of people from our advisory committee, combined with Biological Resources Division scientists and university people?

Every park needs to understand the conditions, the "vital signs" of its ecosystems and the normal variation of those vital signs. We need to monitor those vital signs, track them in "state-of-the-park" reports, and then we need to restore them. How do we do that in our restructured environment, knowing that some parks don't have any capability themselves to do that? This is what our strategic plan is aimed to do.

Q: On the whole, where is the Park Service in the process of integrating science in park management?
A: A positive sign was the attention science and resource management got from senior level people at the last George Wright Society conference. I mean, why would a regional director or senior superintendent spend time there unless they're starting to get the message? They're seeing it as important enough to not only send their resource people, but they come and learn, too. And more disciplines are taking an interest, too. Interpreters are taking a much stronger look at their programs, the importance of interpreting, and putting the message out in different forms for our different publics. In the Pacific-West Region, we recently brought back to the Park Service five Senior Scientists who understand the research needs of the parks. They're filling an important liaison role now between park management and the scientific community. To me, these are all good signs. PS

Meetings of Interest

September 28-30

Making Connections, the international conference of the Society for Ecological Restoration, will emphasize the importance of partnerships. Plenary sessions will explore restoration education, rangeland restoration, and restoration across borders, while pre- and post-conference workshops will look at wildlife and riparian restoration and restoration planning. Conference sessions are diverse, including such topics as the restoration of prairies, road removal, and the use of fire in restoration. The gathering will be held at the Austin, Texas, Marriott at the Capitol. Visit *http://www.phil.unt.edu/ser/* on the web for more information.

October 1-3

El Malpais National Monument will host its *10th Anniversary Resource Stewardship Symposium* at The Inn at Grants, New Mexico (505-287-7901). Activities will include research presentations, poster sessions, field trips, and workshops on research planning and stewardship of archeological sites and caves. Registration will be around $30. For registration information contact monument staff at 505-285-4641, x14; for program agenda information contact Herschel Schulz at 505-285-4641, x25 or by e-mail: *herschel_schulz@nps.gov.*

October 6-10

The Natural Areas Association will hold its 25th annual conference at the Mission Point Resort on Mackinac Island, Michigan. Entitled *Planning for the Seventh Generation,* the theme of the conference reflects the Native American tradition of considering how choices made in the present may affect the next seven generations. Primary topics will include a discussion on the past, present, and future of natural areas and the role of natural areas in conservation planning and sustainable development. For more information contact the Natural Areas Association at 517-241-2974 or visit *http://wildlife/dnr.state.mi.us/HomePages/Meetings/Natural_Areas_1998* on the web.

October 13-16

The Fifth Conference on Fossil Resources, *Partners Preserving our Past, Protecting our Future,* will take place in Rapid City, South Dakota, at the Rushmore Plaza Holiday Inn. Like its predecessors, this conference will bring together professionals from numerous federal and state agencies who are involved in the management, interpretation, and protection of paleontological sites. Themes will include science and research on public lands; education and outreach; paleontology and the public trust; technology and paleontology; paleontological resource management; partnerships; and curation and conservation. Contact Rachel Benton *(rachel_benton@nps.gov)* of Badlands National Park for registration information at 605-433-5361.

March 22-26, 1999

The 10th George Wright Society conference on research and resource management in parks and on public lands is now in the planning stages. To be held in Asheville, North Carolina, near Great Smoky Mountains National Park, *On the Frontiers of Conservation: Discovery, Reappraisal, and Innovation,* is organized around three concurrent sessions: a management track, an analysis and synthesis track, and a track devoted to Appalachian issues. Abstracts are being accepted until October 15. For more information visit the website *http://www.portup.com/~gws/gws99.html* or contact the society at *gws@mail.portup.com* or 906-487-9722.

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*GPO 673-053

This issue was never published

Volume 18:no.2 (1998)